PB90-252503

Hazardous Waste Treatment, Storage, and Disposal Facilities Background Information for Promulgated Organic Emission Standards for Process Vents and Equipment Leaks

(U.S.) Environmental Protection Agency, Research Triangle Park, NC

Jun 90

U.S. Department of Commerce
National Technical Information Service
NTIS

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before complet

1. REPORT NO. EPA-450/3-89-009	2.	3. PB90-252503

4. TITLE AND SUBTITLE Hazardous Waste Treatment, Storage, and Disposal Facilities--Background Information for Promulgated Organic Emission Standards for Process Vents and Equip-	5. REPORT DATE June 1990
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) ment Leaks	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Office of Air Quality Planning and Standards Environmental Protection Agency Research Triangle Park, North Carolina 27711	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO. 68-02-4326
12. SPONSORING AGENCY NAME AND ADDRESS DAA for Air Quality Planning and Standards Office of Air, Noise, and Radiation U.S. Environmental Protection Agency Research Triangle Park, North Carolina 27711	13. TYPE OF REPORT AND PERIOD COVERED
	14. SPONSORING AGENCY CODE EPA/200/04

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Standards for the control of organic air emissions from hazardous waste treatment, storage, and disposal facilities (TSDF) and waste solvent treatment facilities (WSTF) are promulgated under the authority of Section 3004(n) of the 1976 Resource Conservation and Recovery Act (RCRA). These standards would apply to certain process vents associated with distillation and stripping equipment at WSTF (and at TSDF, if applicable) and to fugitive emissions from equipment leaks at TSDF where the waste stream (or its derivatives) contain 10 percent or more total organics. This document contains summaries of public comments received on the proposed rule (February 5, 1987), EPA responses, and a discussion of differences between the proposed and final standards.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air pollution	Recycling	Air pollution control	13 B
Benzene	Treatment, storage, and disposal facilities		
Carcinogenic	Volatile organics		
Equipment leaks	Waste solvent treatment facilities		
Hazardous waste			
National emission standards for hazardous air pollutants			
Process vents			

18. DISTRIBUTION STATEMENT Unlimited	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

PB90-252503

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

EPA-450/3-89-009
June 1990

Air

EPA

Hazardous Waste Treatment, Storage, and Disposal Facilities -- Background Information for Promulgated Organic Emission Standards for Process Vents and Equipment Leaks

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

EPA-450/3-89-009

Hazardous Waste Treatment, Storage, and Disposal Facilities Background Information for Promulgated Standards for Process Vents and Equipment Leaks

Emissions Standards Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711
June 1990

This report has been reviewed by the Emission Standards Division of the Office of Air Quality Planning and Standards, EPA, and approved for publication. Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use. Copies of this report are available through the Library Services Office (MD-35), U.S. Environmental Protection Agency, Research Triangle Park NC 27711, or from National Technical Information Services, 5285 Port Royal Road, Springfield VA 22161.

ENVIRONMENTAL PROTECTION AGENCY

Background Information for Promulgated Organic Emission Standards for Process Vents and Equipment Leaks

Prepared by:

6/7/90

Jack R. Farmer
Director, Emission Standards Division
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

(Date)

1. The standards would limit organic air emissions as a class at hazardous waste treatment, storage, and disposal facilities (TSDF) that are subject to regulation under Subtitle C of the Resource Conservation and Recovery Act (RCRA). The rule establishes final standards limiting organic emissions from process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction, air or steam stripping operations that manage hazardous wastes with at least 10 ppmw total organics concentration, and leaks from equipment (e.g., pumps and valves) that contain or contact hazardous waste streams with 10 percent or more total organics. The final standards are promulgated under authority of Section 3004 of the Hazardous and Solid Waste Amendments to RCRA. The EPA is required by Section 3004(n) of RCRA to promulgate standards for monitoring and control of air emissions from hazardous waste TSDF as necessary to protect human health and the environment.

2. Copies of this document have been sent to the following Federal Departments: Labor, Health and Human Services, Defense, Office of Management and Budget, Transportation, Agriculture, Commerce, Interior, and Energy; the National Science Foundation; and the Council on Environmental Quality. Copies have also been sent to members of the State and Territorial Air Pollution Program Administrators; the Association of Local Air Pollution Control Officials; EPA Regional Administrators; and other interested parties.

3. For additional information on the regulatory aspects of these standards, contact:

   Mr. Rick Colyer
   Standards Development Branch (MD-13)
   U.S. Environmental Protection Agency
   Research Triangle Park, NC 27711
   Telephone: (919) 541-5262.

For additional information on the technical aspects of these standards, contact:

Mr. Robert Lucas
Chemicals and Petroleum Branch (MD-13)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711
Telephone: (919) 541-0884

For additional information on the test methods associated with these standards, contact:

Mr. Terry Harrison
Emission Measurement Branch (MD-13)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711
Telephone: (919) 541-5233

4. Copies of this document may be obtained from:

U.S. EPA Library (MD-35)
Research Triangle Park, NC 27711

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

CONTENTS

Chapter **Page**

Figures ix
Tables ix

1.0 Summary 1-1
  1.1 Summary of Changes Since Proposal 1-2
  1.2 Summary of Impacts of Promulgated Action 1-6

2.0 Summary of Public Comments 2-1

3.0 Regulatory Issues 3-1
  3.1 Selection of Source Category 3-1
    3.1.1 Land Disposal Restrictions 3-1
    3.1.2 Ozone 3-5
    3.1.3 Equity of Coverage 3-6
    3.1.4 Pollutants 3-7
    3.1.5 Equipment and Sources 3-9
  3.2 Statutory Authority and Regulatory Approach 3-21
    3.2.1 RCRA vs. the CAA 3-21
    3.2.2 Level of Control Under RCRA 3-24
    3.2.3 Consideration of Costs 3-27
    3.2.4 RCRA Section 3004(n) 3-28
    3.2.5 RCRA Authority to Control Reclaimed Commercial Product 3-29
    3.2.6 Total Organics Approach 3-29
    3.2.7 Transfer of the Benzene NESHAP Technology 3-33
    3.2.8 Accelerated Approach 3-34

4.0 Applicability and Exemptions 4-1
  4.1 Applicability of Standards for Storage Tanks and Accumulator Vessels 4-1
  4.2 Selection of the 10-Percent Cutoff 4-2
  4.3 Exemptions for Small Solvent Recovery Operations 4-5
  4.4 Totally Enclosed Treatment Facility Exemption 4-8
  4.5 Exemption for 90-Day Storage 4-10
  4.6 Leak Detection and Repair (LDAR) Program 4-11
    4.6.1 Exemption for Light/Heavy Liquids 4-11
    4.6.2 Exemption for Small Facilities 4-13
    4.6.3 Exemption for Vacuum Systems 4-14
    4.6.4 Flanges and Pressure Relief Devices 4-15

CONTENTS (con.)

Chapter Page

4.6.5 Directed Maintenance, Leak Definition, and Petition for Reconsideration of the Benzene Standards 4-16
4.7 References 4-19

5.0 Environmental Impacts 5-1
5.1 Data, Analyses, and Methodology 5-1
5.2 Model Plant Emission Estimates 5-4
5.3 Flow Rate 5-8
5.4 Adjustment for Volatility 5-10
5.5 Number of Facilities 5-11
5.6 Adequacy of Data and Information Supporting the Impact Analyses 5-12

6.0 Health Risk Impacts 6-1
6.1 Representativeness of Waste Streams 6-1
6.2 Unit Risk Factors 6-13
6.3 Methodology 6-17
6.4 Additive and Synergistic Effects 6-20
6.5 Dispersion Modeling 6-22
6.6 Worker Exposure..................................... 6-23
6.7 Level for Standards 6-24

7.0 Selection of Standards 7-1
7.1 Emission Cutoff for Process Vents 7-1
7.2 Feasibility of a 95-Percent Control 7-10
7.3 Feasibility of Condensers 7-12
7.4 Feasibility of Flares 7-15
7.5 Feasibility of Carbon Adsorbers 7-16
7.6 Feasibility of Leak Detection and Repair (LDAR) Program 7-21
7.7 Feasibility of Using Controls in Series 7-25
7.8 Reference 7-27

8.0 Cost Impacts 8-1
8.1 Carbon Adsorber Cost Estimates 8-1
8.2 Condenser Costs 8-3
8.3 Compliance Costs 8-5
8.4 Compliance Costs for LDAR Program 8-6
8.5 Recovery Credit for TSDF 8-9
8.6 Cost Effectiveness of Process Vent Control Techniques 8-10
8.7 Cost of a Fixed 95-Percent Emission Reduction 8-14

9.0 Economic Impacts 9-1
9.1 Small Business Impacts.............................. 9-1
9.2 Closures and Other Economic Impacts................. 9-4

CONTENTS (con.)

Chapter Page

10.0 Test Methods.. 10-1
10.1 Measurement of the 10-Percent Total Organics........ 10-1
10.2 Determination of Equipment in VHAP Service.......... 10-7
10.3 Fugitive Emission Monitoring by Method 21........... 10-8

11.0 Implementation and Compliance Provisions 11-1
11.1 Compliance Dates 11-1
11.1.1 Overall Standards 11-1
11.1.2 Period for LDAR 11-5
11.2 Permits 11-7
11.2.1 State and Local Role 11-7
11.2.2 Part B Information Requirements 11-8
11.3 Compliance Provisions 11-9
11.3.1 Documentation 11-9
11.3.2 Special Requirements 11-9
11.3.3 Alternative Means of Emission Limitation ... 11-10
11.4 Recordkeeping and Reporting 11-11
11.4.1 Frequency of Reports 11-11
11.4.2 Duplication of Reports 11-12
11.4.3 Notification 11-13
11.5 Implementation and Enforcement 11-14
11.5.1 Guidance on the 95-Percent Limit 11-14
11.5.2 Omnibus Permitting 11-15
11.5.3 State and Regional Role 11-19
11.5.4 LDAR Enforcement Approach 11-19
11.6 Miscellaneous 11-20

Appendix

A Evolution of Promulgated Standards........................ A-1

B Estimating Health Effects................................. B-1

C Control Costs C-1

D Source Assessment Model................................... D-1

FIGURES

Number Page

7-1 Emission rate cutoff vs. maximum individual risk (high emissions) 7-6
7-2 Emission rate cutoff vs. incidence (high emissions) 7-7
7-3 Emission rate cutoff vs. emission reduction (high emissions) 7-8

8-1 Emission rate vs. cost effectiveness (condensers @ 95%) 8-11
8-2 Emission rate vs. cost effectiveness (carbon adsorption) 8-12
8-3 Emission rate vs. cost effectiveness (incinerators @ 98%) 8-13

TABLES

Number Page

2-1 List of Commenters on Proposed Air Emission Standards for Hazardous Waste Treatment, Storage, and Disposal Facilities 2-2

4-1 Air Stripper Data Summary 4-6

5-1 Model Unit: Process Vent Emissions 5-6

6-1 Summary of WSTF/TSDF Waste Stream Constituents 6-3
6-2 Information for TSDF Constituents........ 6-5
6-3 Vent Emissions Constituent Data Summary for Steam Stripper and Distillation Units........ 6-8
6-4 Vent Emissions Constituent Range and Frequency........ 6-11

7-1 Summary of Process Vent Risk Analysis (Incidence) 7-4
7-2 Summary of Process Vent Risk Analysis (MIR) 7-5

8-1 Estimates of Mid-Sized Recycling Model Unit Compliance Costs 8-7

9-1 Price and Quantity Adjustments in the Markets for Goods and Services by Generating Sector, Equipment Leak Fugitive Emission Control 9-3

1.0 SUMMARY

On February 5, 1987 (52 FR 3748), the U.S. Environmental Protection Agency (EPA) proposed standards limiting emissions of volatile organic pollutants from process vents and equipment leaks at new and existing hazardous waste transfer, storage, and disposal facilities (TSDF) where (a) equipment at the facilities contain hazardous wastes or derivatives of hazardous wastes, and (b) these wastes or their derivatives contain 10 percent or more total organics. These regulations were proposed under the authority of Section 3004(n) of the Resource Conservation and Recovery Act (RCRA) as amended. The proposed standards would have required that emissions from all process vents that emit organics in concentrations of 10 percent or greater on all TSDF waste management units, such as vents on condensers, steam strippers, air strippers, thin-film evaporators, distillation operations, and vents on product accumulator vessels, be reduced by at least 95 percent. The impacts of the proposed standards were based on the use of secondary condensers, although the standards also would have allowed the use of carbon adsorbers, flares, or other controls. In addition, facilities would have been required to monitor operation of the control devices after installation.

The proposed standards also would have required implementation of a leak detection and repair (LDAR) program for valves and pumps and equipment leak standards for compressors, pressure relief devices, sampling connection systems, open-ended valves or lines, pipeline flanges, and closed vent systems and control devices used to comply with the standards that handle hazardous waste and their derivatives at TSDF. Control systems, leak detection methodology, leak definitions, and repair schedules were based on existing standards developed under Sections 111 and 112 of the Clean Air Act (CAA).

The process vents that would have been covered by the proposed standards generally are associated with equipment (including product accumulator vessels such as distillate receivers, surge control vessels, product separators, or hot wells) used to distill, evaporate, or steam and air strip organic components from hazardous waste. Such separation techniques can occur in solvent reclamation operations, wastewater treatment, or other pretreatment processes. Therefore, the proposed standards would have regulated the process of reclamation (and resulting air emissions) for the first time. However, only those facilities already subject to RCRA permit requirements, including facilities that perform reclamation and require a permit for another part of their operation, would have been subject to the proposed standards. Therefore, the proposed rule would have added 40 CFR 261.6(d) so that reclamation activities at permitted facilities would be subject to air emission standards.

Public comments were requested on the proposal in the Federal Register. A total of 60 comments were received, predominantly from affected companies and trade associations. Also commenting were other Federal agencies and departments, various State air pollution control and solid and hazardous waste management departments, one environmental group, and one private citizen. The comments that were submitted, along with responses to these comments, are summarized in this document. The summary of comments and responses serves as the basis for the revisions made to the standard between proposal and promulgation.

1.1 SUMMARY OF CHANGES SINCE PROPOSAL

Since proposal, EPA has evaluated the comments received, collected and assessed additional information, and made changes to the final rules as a result of comments on the proposed rules. First, the applicability of the process vent standards has been limited to (1) process vents on distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping operations that manage hazardous wastes with total organic concentrations of at least 10 ppmw (annual average) and vents on condensers serving these operations, and (2) process vents on tanks (e.g., distillate receivers, bottoms receivers, surge control tanks, separator tanks, and hot wells) associated with distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping processes that manage hazardous wastes with total organic concentrations of at least 10 ppmw (annual average) if emissions from these process operations are vented through the tanks. In the final standards, uncondensed overhead from the process unit is subject to air emission controls. If emissions from the process unit or a condenser serving the unit are not vented through these tanks (i.e., are vented directly to the atmosphere or through a vacuum pump), then emissions from vent(s) that may be present on the tanks are not subject to the process vent standards. The applicability of today's final standards for process vents has been limited because the control technology assessments and the emissions and risk analyses needed to support extension of the process vent standards to other closed (covered) and vented tanks not associated with these processes have not yet been completed. They are being developed in conjunction with the Phase II Section 3004(n) air emission standards now being developed for proposal in mid-1990.

To avoid confusion with tanks that are not associated with the processing of waste streams, and therefore are not subject to RCRA authority, the term "product accumulator vessel" has been deleted from the final standard and affected equipment are more specifically defined. In addition, the terms "volatile hazardous air pollutant (VHAP)" and "in VHAP service" have been deleted, and the wording of the final process vent regulation has been revised to reflect applicability based on clearly specified hazardous waste management processes or unit operations that have vents emitting organics to the atmosphere.

The final rules for process vents add a facility-based emission rate limit of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) representing the total emissions from all affected process vents at the facility. Facilities with organic emissions from affected vents below these emission rate limits will not have to install controls or monitor process vent emissions. Based on the final emissions and risk analyses, limits of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) exempt from control requirements only emissions that do not pose significant risk. Facilities that exceed the limits must either reduce organic emissions from process vents to below the emission rate limits or reduce, by use of a control device, total organic emissions from process vents at the facility by 95 weight percent. If enclosed combustion devices (i.e., incinerators, boilers, or process heaters) are used, the owner/operator has the option of reducing the organic concentration of each affected vent stream at the facility to no more than 20 parts per million by volume (ppmv). The final regulations place the burden of proof on the facility to demonstrate through test data or engineering calculations that the facility would never be expected to exceed the emission limits.

Another major change affects the applicability of the final standards for equipment LDAR. The LDAR requirements for pumps and valves have been revised to include the light and heavy liquid provisions contained in EPA's new source performance standard (NSPS) for equipment leaks of volatile organic compounds (VOCs) in the synthetic organic chemicals manufacturing industry (SOCMI) (40 CFR 60, Subpart VV). Thus, in response to comments, the equipment standards take volatility into consideration. Equipment are in light liquid service if the vapor pressure of one or more of the components is greater than 0.3 kPa at 20 °C, if the total concentration of the pure components having a vapor pressure greater than 0.3 kPa at 20 °C is equal to or greater than 20 percent by weight, and if the fluid is a liquid at operating conditions. Because equipment processing organic liquids with vapor pressures below 0.3 kPa tend to leak at lower emission rates and frequencies than do equipment processing streams with vapor pressures above 0.3 kPa, the final rules exempt equipment processing lower vapor pressure substances (i.e., heavy liquids) from the routine LDAR requirements of the standards unless there is evidence of a leak by visual, audible, olfactory, or any other detection method. As proposed, the LDAR program would have been implemented at those facilities where equipment contacts waste streams containing 10 percent by weight or more total organics without regard to component volatility. A facility may choose any of the applicable test methods identified in the final rules for determining the organic content.

Because of commenters' concerns with the administrative burden (i.e., time and cost) involved in obtaining a major permit modification, the final standards do not require modifications of permits issued before the effective date. Hazardous waste management units and associated process vents and equipment affected by these standards must be added or incorporated into the permit at review under Section 270.50 or reissue under Section 124.15.

Several changes have been made to the monitoring, reporting, and recordkeeping requirements of the standards since proposal in response to concerns with the compliance provisions. Under RCRA statutory requirements (Section 3010(b) of RCRA), compliance must be attained by the effective date of the rule (i.e., promulgation date plus 6 months). However, a facility that documents that an emission control device required by the rules cannot be installed by the effective date can complete an implementation schedule. The implementation schedule for the installation of controls may allow up to 2 years after promulgation to complete installation, but the interim dates for design, commencement of construction, and completion of construction have been deleted. The implementation schedule must be in the facility's operating record no later than 6 months following promulgation of the final rules. Additional, more detailed information on implementation aspects is presented in Chapter 11. As a clarification, specific parameters that must be considered in the control device design have been added to the standards for interim-status and permitted facilities. Similarly, the monitoring requirements for control device operating parameters have been made more specific for interim-status facilities and have been added to the requirements for permitted facilities. The semiannual reporting requirements for facilities with final permits have been reduced to include only exceedances of the process vent and equipment-leak provisions; there are no reporting requirements for interim-status facilities. For clarity, specific definitions of exceedances for process vents in terms of the monitored operating parameters have been added. Records of exceedances also must be kept in the facility operating log.

The proposed air emission standards for process vents and equipment leaks would have added Subpart C of Part 269, Air Emission Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. For consistency with standards for other TSDF sources under RCRA, the final standards have been incorporated into Parts 264, for permitted facilities, and 265, for interim-status facilities. Subpart AA applies to process vents and Subpart BB to equipment leaks. In addition, whereas at proposal the equipment-leak requirements of 40 CFR Part 61, Subpart V, were incorporated by reference, these provisions have been written into Subpart BB with editorial revisions appropriate for a standard promulgated under RCRA authority rather than CAA authority. For example, the terms "in VHAP service" and "product accumulator vessel" have been deleted, and exceedances have been specifically defined such that only exceedances must be reported on a regular basis, which is consistent with RCRA enforcement procedures.

1.2 SUMMARY OF IMPACTS OF PROMULGATED ACTION

The EPA revised and expanded the impact analyses, including estimates of emissions, risks, costs, and the economic impact on small businesses and on the industry as a whole. Although the results of these analyses differ from the impact estimates at proposal, EPA's conclusion that TSDF should be regulated remains unchanged. Based on the revised impact analyses, nationwide uncontrolled organic emissions from process vents at about 450 TSDF with solvent recovery operations range from 300 Mg/yr or 330 ton/yr (based on lower bound emission rates) to 8,100 Mg/yr or 8,900 ton/yr (based on upper bound emission rates). This wide emission range occurs because of variations in primary condenser recovery efficiencies and the presence of secondary condensers at some sites.

A weighted-average unit risk factor of 4.5×10^{-6} cases/μg/m^3/person was used to estimate the maximum individual risk (MIR) of contracting cancer and the annual cancer incidence associated with baseline process vent emissions. The MIR is the theoretical individual living in the vicinity of a TSDF with the highest exposure and therefore the highest risk of contracting cancer over a 70-year lifetime. Based on the estimated lower bound emission rates and weighted-average unit risk factor, the current MIR is 3×10^{-5} and the incidence is 0.015 case/yr. Based on the upper bound emission rate and weighted-average unit risk factor, the current MIR is 8×10^{-4} and the incidence is 0.38 case/yr.

Equipment-leak fugitive emissions from waste streams containing at least 10 percent total organics by weight are estimated at 26,200 Mg/yr (29,000 ton/yr). This estimate includes emissions from over 1,400 TSDF with waste management processes handling waste with at least 10 percent organics, including solvent recycling operations and incinerators and boilers. The MIR resulting from TSDF fugitive emissions is estimated at 5×10^{-3} and the annual incidence at 1.1 cases/yr, based on an equipment-leak, emission-weighted arithmetic mean unit risk factor of 4.5×10^{-6}. Further information regarding the emissions and risk analyses can be found in Chapters 5.0 and 7.0, respectively, of this document. Information on the costs and economic analyses is presented in Chapters 8.0 and 9.0, respectively.

With the application of the final process vent standards, approximately 45 percent of the 450 TSDF with process vents will not require additional control. However, nationwide organic emissions from process vents at the affected facilities will be reduced to a range of 260 Mg/yr or 290 ton/yr (lower bound emission rates) to 900 Mg/yr or 990 ton/yr (upper bound emission rates). Based on lower bound emission rates, the MIR will be reduced to 2×10^{-6} from 3×10^{-5}; annual incidence will be reduced to 0.001 from 0.015 case/yr. Based on the upper bound emission rates, the MIR will be reduced to 4×10^{-5} from 8×10^{-4}, and the annual incidence will be reduced to 0.027 case/yr from 0.38 case/yr.

With the implementation of LDAR programs for fugitive emissions, nationwide organic emissions will be reduced to about 7,200 Mg/yr (7,900 ton/yr). The MIR and incidence associated with fugitive emissions will be reduced to about 1×10^{-3} and 0.32 case/yr, respectively. The EPA believes that the emissions and risk reductions achievable by these standards are needed to protect human health and the environment.

2.0 SUMMARY OF PUBLIC COMMENTS

A total of 60 letters commenting on the proposed standards and the background information document (BID) for the proposed standards were received. A list of commenters, their affiliations, and the EPA docket number assigned to their correspondence is given in Table 2-1.

For the purpose of orderly presentation, the comments have been categorized under the the following topics:

•	Chapter 3.0	Regulatory Issues
•	Chapter 4.0	Applicability and Exemptions
•	Chapter 5.0	Environmental Impacts
•	Chapter 6.0	Health Risk Impacts
•	Chapter 7.0	Selection of Standards
•	Chapter 8.0	Cost Impacts
•	Chapter 9.0	Economic Impacts
•	Chapter 10.0	Test Methods
•	Chapter 11.0	Implementation and Compliance Provisions.

TABLE 2-1. LIST OF COMMENTERS ON PROPOSED AIR EMISSION STANDARDS FOR HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

Docket item number	Commenter name and address	Docket item number	Commenter name and address
F-86-AESP-00001	Calvin L. Sonner Route 2, Box 191A Strasburg, VA 22657	F-86-AESP-00008	Harry H. Hovey, Jr., P.E. Director, Division of Air Resources New York State Department of Environmental Conservation 50 Wolf Road Albany, NY 12233-3250
F-86-AESP-00002	David J. Carlson Environmental Control Supervisor McLaughlin Gormley King Company 8810 Tenth Avenue North Minneapolis, MN 55427	F-86-AESP-00009	Robert Heltzer Manager of Technical Services Milwaukee Solvents & Chemicals Corporation P.O. Box 444 Butler, WI 53007
F-86-AESP-00003	Allan A. Griggs, P.E. Project Manager Diamond Shamrock Refining and Marketing Company P.O. Box 696000 San Antonio, TX 78269-6000	F-86-AESP-00010	R. R. Kienle, Manager Environmental Affairs Shell Oil Company One Shell Plaza P.O. 4320 Houston, TX 77210
F-86-AESP-00004	Peter Schnieder Vice President Romic Inc. 2081 Bay Road East Palo Alto, CA 94303	F-86-AESP-00011	B. F. Ballard, Director Environmental Control Phillips Petroleum Company 13 A4 Phillips Building Bartlesville, OK 74004
F-86-AESP-00005	George L. Williamson Compliance Manager M&M Chemical Company P.O. Box 291 Gadsden, AL 35902	F-86-AESP-00012	Richard A. Lemen, Director Division of Standards Development and Technology Transfer Department of Health and Human Services National Institute for Occupational Safety and Health Robert A. Taft Laboratories 4676 Columbia Parkway Cincinnati, OH 45226-1998
F-86-AESP-00006	Verrill M. Norwood, Jr. Vice President Environmental Affairs Olin Chemicals P.O. Box 248 Lower River Road Charleston, TN 37310	F-86-AESP-00013	Carol J. Battershell Corporate Environmental Specialist The Standard Oil Company 200 Public Square Cleveland, OH 44114-2375
F-86-AESP-00007	P.E. Gerwert, Manager Industrial Waste and Toxic Substances General Motors Corporation General Motors Technical Center 30400 Mound Road Warren, MI 48090-9015	F-86-AESP-00014	John F Chadbourne, Ph.D Director of Environmental Services General Portland Inc. 12001 North Central Expressway North Central Expressway Plaza III Suite 1700 P.O. Box 324 Dallas, TX 75221

(continued)

TABLE 2-1 (continued)

Docket item number	Commenter name and address
F-86-AESP-00015	Gary D. Vest Director for Environment, Safety, and Occupational Health Department of the Air Force Washington, DC 20330-1000
F-86-AESP-00016	James R. Hulm President National Asociation of Solvent Recyclers 1333 New Hampshire Avenue, NW Washington, DC 20036
F-86-AESP-00017	M. L. Mullins, Director Regulatory Management Monsanto Company 1101 17th Street, NW Washington, DC 20036
F-86-AESP-00018	Phillip J. Bateman Corporate Director Environmental Assurance The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, OH 44092
F-86-AESP-00019	Alan D. Wasserman Honigman Miller Schwartz and Cohn 2290 First National Building Detroit, MI 48226
F-86-AESP-00020	Lewis D. Walker Deputy for Environment, Safety, and Occupational Health (OASA-IAL) Office of the Assistant Secretary Department of the Army Washington, DC 20310-0103
F-86-AESP-00021	James D. Boyd Executive Officer State of California Air Resources Board 1102 Q Street P.O. Box 2815 Sacramento, CA 95812
F-86-AESP-00022	Eliot Cooper Director of Environmental Affairs Waste-Tech Services, Inc. 18400 W. 10th Avenue Golden, CO 80401
F-86-AESP-00023	Carlene Bnssell, P.E. Manager, Environmental Technology Lederle Laboratories Pearl River, NY 10965
F-86-AESP-00024	Alan T. Roy, P.E. Manager, Pollution Control Allied Fibers Allied Corporation Chesterfield Plant P.O. Box 831 Hopewell, VA 23860
F-86-AESP-00025	Kevin J. Igli Regulatory Affairs Manager Government Affairs Department Waste Management, Inc. 1155 Connecticut Avenue, NW Suite 800 Washington, DC 20036
F-86-AESP-00026	Richard A. Svanda Director Solid And Hazardous Waste Division Minnesota Pollution Control Agency 520 Lafayette Road North St. Paul, MN 55155
F-86-AESP-00027	Kirk Thomson, Manager Environmental Affairs The Boeing Company P.O. Box 3707 Seattle, WA 98124-2207
F-86-AESP-00028	Dr. J.F. Terenzi, Director Engineering, Toxicology, and Environmental Services Chemicals Group American Cyanamid Company One Cyanamid Plaza Wayne, NJ 07470
F-86-AESP-00029	G. Mahoney Environmental Coordinator Heritage Environmental Services, Inc. 7901 West Morris Street Indianapolis, IN 46231

(continued)

TABLE 2-1 (continued)

Docket item number	Commenter name and address
F-86-AESP-00030	William F. O'Keefe Vice President American Petroleum Institute 1220 L Street, NW Washington, DC 20005
F-86-AESP-00031	R. Stan Jorgensen, Director Waste Management Program Missouri Department of Natural Resources Division of Environmental Quality P.O. Box 176 Jefferson City, MO 65102
F-86-AESP-00032	David M. Lusk, Vice President Michigan Disposal, Inc. P.O. Box 6118 Dearborn, MI 48120
F-86-AESP-00033	Leo J. Domzalski Production Engineering Manager Nalco Chemical Company One Nalco Center Naperville, IL 60566-1024
F-86-AESP-00034	William Juris, P.E. Engineering Section Division of Air Pollution Control Ohio Environmental Protection Agency P.O. Box 1049 361 East Broad Street Columbus, OH 43266-1049
F-86-AESP-00035	J. C. Edwards Manager, Clean Environment Program Eastman Kodak Eastman Chemicals Division Kingsport, TN 37662
F-86-AESP-00036	James Parvechio, Jr. Vice President Arivec Chemicals, Inc. 7962 Huey Road P.O. Box 64 Douglasville, GA 30133
F-86-AESP-L0001	Geraldine V. Cox Chemical Manufacturers Association 2501 M Street NW Washington, DC 20037
F-86-AESP-L0002	Sandra S. Newman Manager of Environmental Affairs Sterling Chemicals P.O. Box 1311 Texas City, TX 77592-1311
F-86-AESP-L0003	Stanley A. Walczynski Treatment Operations Safety-Kleen 777 Big Timber Road Elgin, IL 60123
F-86-AESP-L0004	C.M. Duesler Commanding Officer Naval Air Rework Facility North Island San Diego, CA 92135
F-86-AESP-L0005	Walter R. Quanstrom General Manager (Mail Code 4902) Environmental Affairs and Safety Department Amoco Corporation 200 East Randolph Drive Chicago, IL 60601
F-86-AESP-L0006	Thomas A. Robinson, Ph.D. Director, Environmental Affairs Vulcan Chemicals P.O. Box 7689 Birmingham, AL 35253
F-86-AESP-L0007	C. P. Gorman, Director Environmental Affairs Division Eli Lilly and Company Lilly Corporate Center Indianapolis, IN 46285
F-86-AESP-L0008	W. Caffey Norman, III Heron, Burchette, Ruckert & Rothwell Suite 700 1025 Thomas Jefferson Street, NW Washington, DC 20007

(continued)

TABLE 2-1 (continued)

Docket item number	Commenter name and address
F-86-AESP-L0009	Charlene Esparza-Baca Environmental Engineer U.S. Department of Energy Albuquerque Operations Los Alamos Area Office Los Alamos, NM 87544
F-86-AESP-L0010	Colonel Rockwood S. Dunham Staff Director Installation Services and Environmental Protection U.S. Department of Defense Defense Logistics Agency Cameron Station Alexandria, VA 22304-6100
F-86-AESP-L0011	R. B. Morris, Jr. Director, Environmental Programs IBM 208-262 Harbor Drive P.O. Box 10501 Stamford, CT 06904-2501
F-86-AESP-L0012	Warren W. Tyler Ohio Environmental Protection Agency P.O. Box 1049 361 E. Broad Street Columbus, OH 43266-1049
F-86-AESP-L0013	Peter D. Venturini, Chief Stationary Source Division California Air Resources Board 1102 Q Street P.O. Box 2815 Sacramento, CA 95812
F-86-AESP-L0014	James R. Hulm National Association of Solvent Recyclers 1333 New Hampshire Avenue, NW Washington, DC 20036
F-86-AESP-L0015	Raymond P. Berube Acting Director Office of Environmental Guidance and Compliance U.S Department of Energy Washington, DC 20585
F-86-AESP-L0016	Deborah A. Sheiman Resource Specialist Natural Resources Defense Council 1350 New York Avenue, NW Washington, DC 20005
F-86-AESP-L0017[a]	Kevin J. Igli Regulatory Affairs Manager Government Affairs Department Waste Management, Inc. 1155 Connecticut Avenue, NW Suite 800 Washington, DC 20036
F-86-AESP-L0018	Kevin J. Igli Regulatory Affairs Manager Government Affairs Department Waste Management, Inc. 1155 Connecticut Avenue, NW Suite 800 Washington, DC 20036
F-86-AESP-L0019	OMB
F-86-AESP-L0020[b]	James R. Hulm President National Association of Solvent Recyclers 1333 New Hampshire Avenue, NW Washington, DC 20036
F-86-AESP-L0021[b]	Alan D. Wasserman Honigman Miller Schwartz and Cohn 2290 First National Building Detroit, MI 48226
F-86-AESP-L0022[b]	Kevin J. Igli Regulatory Affairs Manager Government Affairs Department Waste Management, Inc. 1155 Connecticut Avenue, NW Suite 800 Washington, DC 20036
F-86-AESP-L0023[b]	Robert Heltzer Manager of Technical Services Milwaukee Solvents & Chemicals Corporation P.O. Box 444 Butler, WI 53007

See notes at end of table.

(continued)

TABLE 2-1 (continued)

Docket item number	Commenter name and address	Docket item number	Commenter name and address.
F-88-AESP-L0024[b]	Richard A. Svanda Director Solid and Hazardous Waste Division Minnesota Pollution Control Agency 520 Lafayette Road North St. Paul, MN 55155 Rahway, NJ 07065-0900	F-88-AESP-L0025	Dorothy P. Bowers Executive Director Environmental Resources Merk & Co., Inc. P.O. Box 2000

[a] Request for comment period extension.
[b] Submission of additional information.

3.0 REGULATORY ISSUES

3.1 SELECTION OF SOURCE CATEGORY

3.1.1 Land Disposal Restrictions

Comment: Five commenters questioned the presumption that the land disposal restrictions (LDR) will cause an increase in the volume of solvent for recycling as the basis for selecting hazardous waste TSDF (including commercial recyclers) as a source category for regulation. In support, Commenters AESP-00004, AESP-00016, AESP-00024, AESP-00025, and AESP-L0003 explain the volume of solvent destined for recycling actually has decreased because: (1) generators are recycling to the extent possible and solidifying the rest; the resulting solids are incinerated if they cannot be land disposed; (2) the solvents banned by the restrictions often are nonrecyclable and are used instead as supplemental fuel or are incinerated; (3) generators are allowing the solvent waste (once sent to a landfill) to remain mixed with the used solvent they do recycle, which reduces the solvent yield and makes using the solvents as supplemental fuel more economically attractive; and (4) the restrictions affect only the clearly residual wastes of low solvent content that are being shifted from land disposal to incineration. Commenter AESP-00025 also submitted a survey showing that their wastes being recycled actually have decreased as a result of the restrictions, whereas the waste volume shipped to industrial furnaces and boilers has increased.

Response: It is important to point out that LDR was not the basis for selecting hazardous waste TSDF (which includes commercial recyclers) equipment leak and process vent emissions as a source category for regulation. The ambient air concentrations of organics emanating from these sources at TSDF increase the individual's (general public's) probability or odds of getting cancer, and they add to the prevailing cancer incidence. The EPA has determined the public health risk of ambient air exposure to organics emitted from TSDF to be significant. Therefore, the Administrator has decided to take measures to reduce the atmospheric release of organic air pollutants from these sources, regardless of the LDR. The LDR was a consideration in EPA's decision to accelerate the regulations for equipment leaks and process vents independent of other TSDF emission sources. The EPA pursued this phased approach to regulating TSDF emissions to fulfill the Agency's desire to substantially reduce emissions from TSDF as soon as possible and thus to protect human health and the environment from TSDF air emissions.

The EPA chose to develop the process vent and equipment leak portion of its TSDF rulemaking as the first phase of the TSDF air emission rules, partly to prevent uncontrolled air emissions from LDR treatment technologies. The LDR developed under Section 3004(m) of the Hazardous and Solid Waste Amendments (HSWA) require that hazardous waste be treated to reduce concentrations of specific chemicals or hazardous properties to certain performance levels or by certain methods before the waste may be disposed in or on land. The first set of land disposal restrictions, for certain dioxins and solvent-containing hazardous wastes, was promulgated on November 7, 1986 (51 FR 40572); the second set of restrictions, the "California list," was promulgated on July 8, 1987 (52 FR 25760); the "First Third" list was promulgated on August 17, 1988 (53 FR 31138); and the "Second Third" was promulgated on June 23, 1989 (54 FR 26597).

Treatment technologies evaluated under the LDR for nonwastewater spent solvents include distillation/separation processes subject to the requirements of the proposed rule that are considered to be the best demonstrated available technologies (BDAT). Thus, the LDR has the potential of increasing emissions from waste treatment technologies such as steam stripping. The EPA is therefore setting standards to reduce emissions from the technologies expected to be used prior to land disposal to protect human health and the environment.

To better evaluate current emissions and the potential impacts of the accelerated rule, EPA developed an industry profile of onsite and offsite waste solvent recyclers using the most comprehensive information currently available to reevaluate the estimated organic emissions from recycling, the health risk, and EPA's decision to regulate. The survey results are summarized below.

The industry profile was developed using the results of the 1986 National Screening Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities (the Screener Survey). The EPA Office of Solid Waste (OSW) conducted the Screener Survey under RCRA Section 3007 authority. The purpose of the survey was to identify and characterize hazardous waste facilities to determine the size and composition of the sample for the detailed survey of U.S. hazardous waste treatment, storage, disposal, and recycling facilities that is currently being conducted. The Screener Survey data represent all of the TSDF active in 1985 with interim status or final RCRA permits, which totalled about 3,000 facilities. Although EPA recognizes that many changes have occurred since 1985, this is the latest year from which such comprehensive data on recycling currently are available. A copy of the screener data is in the Docket No. F-90-AESF-FFFFF (see item S0015).

A limited amount of information has also been received in response to a Section 3007 questionnaire sent to a small number of selected sites (Docket No. F-90-AESF-FFFFF, items S0017, S0018, S0019, S0020, S0022, S0024 through S0026, S0028 through S0036, and S0038 through S0041). Information available from the Section 3007 responses includes the waste volume recycled in 1985 reported by each facility, recycling operation category (solvent recovery, reuse as fuel, or other recycling), and waste category recycled. This information was used to corroborate Screener Survey results to the extent possible.

The Screener Survey results show that 847 TSDF reported onsite hazardous waste recycling. Of the 847 TSDF recyclers, 448 facilities reported solvent recovery operations by batch distillation, fractionation, or steam stripping, which are processes with vents subject to the promulgated rules. The hazardous waste recovered in batch distillation, fractionation, or steam stripping operations consisted predominantly of solvents, other halogenated organics, and other hazardous wastes. A total of 406 of the 448 facilities handled waste solvents, including 280 facilities reporting recovery operations handling only solvents and 126 facilities reporting solvent recovery operations handling solvents as well as other halogenated organics and other hazardous waste. The total volume of hazardous waste treated by batch distillation, thin-film evaporation, fractionation, and steam stripping was about 1.7 billion L (450 million gal), based on data from 365 of the 448 facilities reporting on solvent recovery operations.

About one-third of the recycling facilities (273 of 847) indicated some reuse of hazardous waste as fuel. Of these 273 facilities, 108 of the facilities indicating solvent reuse as fuel reported no solvent recovery operation of any type onsite. Therefore, transfer and handling operations at these 108 facilities as well as at the 448 facilities reporting solvent recovery by batch distillation, fractionation, thin-film evaporation, or steam stripping are expected to be subject to the equipment leak provisions of the promulgated rules. About 503 million L (133 million gal) of waste, including solvents, were reported by the 94 facilities not having onsite solvent recovery operations that reported a 1985 recycled quantity as being reused as fuel.

Consequently, the Screener Survey shows a minimum total volume of about 2.2 billion L (583 million gal) of hazardous waste recycled in 1985, including 1.7 billion L (450 million gal) of waste being treated by solvent reclamation and 503 million L (133 million gal) being reused as fuel. Not included in this estimate is the volume of solvent being incinerated or treated by "other recycling' (processes other than batch distillation, fractionation, or steam stripping). The EPA considers the 2.2 billion L (583 million gal) a minimum estimate because only about two-thirds of the facilities indicating the presence of recycling operations reported waste volumes. If waste volumes are projected for these facilities based on per-facility reported volumes, the total waste volume treated by solvent reclamation increases to an estimated 2.1 billion L (550 million gal) and the amount reused as fuel increases to 617 million L (163 million gal), for a total volume of 2.7 billion L (713 million gal). This estimate still excludes the waste volume being incinerated or treated by "other recycling."

Although EPA acknowledges that the overall waste volumes may have decreased since 1985 due to waste minimization techniques at certain major facilities, the waste volume being recycled, based on the data cited above, still results in a significant level of emissions and health risk that warrants regulation for protection of human health and the environment. Based on the revised process vent emission factors and model units (see Chapter 5.0), nationwide organic emissions from process vents at affected recycling facilities are estimated to range between 300 Mg/yr (330 ton/yr) and 8,100 Mg/yr (8,900 ton/yr). The range in nationwide organic emission estimates reflects the range of emission factors developed for process vents, representing extreme lower and TSDF process vent on process vent emission rates. Based on the TSDF process vent unit risk factor, estimated cancer cases occurring each year as a result of exposure to process vent emissions may be as high as 0.38 case/yr, and the MIR of developing cancer is about 8 x 10^{-4}. The health risks posed by these sources are considered significant; therefore, the Administrator has decided to take measures to reduce the atmospheric release of organic air pollutants from these sources. Additional information on the emission and risk estimates is presented in Chapters 5.0 and 6.0, respectively, of this document.

3.1.2 Ozone

Comment: Whereas Commenter AESP-L0016 supports efforts to attain the ambient ozone standard, other commenters question the role of ozone in EPA's selection of TSDF as a source category for regulation. Commenters AESP-L0001, AESP-00035, AESP-L0007, and AESP-L0008, state that, on a national and global basis, the chemicals in the solvents that influence ozone depletion yield emissions that represent only a small fraction of the worldwide contribution of these compounds. They also state that ozone is under the purview of the CAA, not RCRA. Commenter AESP-L0025 also states that EPA has presented no evidence that the level of protection necessary for benzene, a carcinogen, is needed for ozone precursors.

Response: The EPA agrees with the commenters in that ozone is a national and global problem. In this regard, EPA is a major supporter of the recent international agreement to limit the manufacture of chlorofluorocarbons to reduce ambient ozone formation and stratospheric ozone depletion. However, EPA does not agree that the impact of the standards on reducing ozone formation is minimal. As discussed in the preamble to the proposed rules at 52 FR 3752, organic emissions contribute to ambient ozone formation in the same way that VOCs contribute to this problem. In fact, TSDF sources as a whole are estimated at nearly 12 percent of all VOC emissions from stationary sources, and any reductions in these emissions also are helpful in reducing ozone formation and associated health problems.

Although VOC emissions have been regulated under the CAA, this does not mean that organic emissions from TSDF may not be regulated under RCRA. Section 3004(n) standards, like all RCRA Subtitle C standards, are to protect "human health and the environment." VOC and ozone are threats to human health and the environment and thus are well within the regulatory scope of Section 3004(n). In addition, organic emissions may contain a variety of toxics, such as carbon tetrachloride, acrylonitrile, and methylene chloride. The control of ozone precursors and the reduction of the air toxics potential of organic emissions are important goals of these standards.

3.1.3 Equity of Coverage

Comment: Ten comments were received that criticized the source category for regulation in that generators, onsite solvent reclaimers, and offsite reclaimers with no prior storage are excluded from control (AESP-00002, AESP-00026, AESP-00007, AESP-00019, AESP-L0003, AESP-L0002, AESP-00027, AESP-00029, AESP-00033, and AESP-00031). Several commenters contend that manufacturing processes emit the vast majority of emissions and should be the focus of regulatory concern; they also dispute EPA's assumption that there would be few offsite reclaimers with no prior storage or onsite reclamation operations. Commenter AESP-00019 points out that there must be hundreds or even thousands of facilities that recycle offsite without prior storage based on the sales by distillation unit vendors. Commenter AESP-00026 indicates knowledge of one offsite recycler without storage and one that emits volatile organometallics. Commenter AESP-00031 states that more than 50 facilities in his State that recycle onsite would not be covered. Commenter AESP-L0016 states that EPA has not provided adequate justification for limiting the coverage of the proposed rule. This commenter does not find EPA's rationale compelling because:

- The EPA has not shown that the need to protect human health and the environment is any less a concern at the facilities that are not required to have a permit than at the facilities that are.

- The fact that CAA standards may apply to some of the facilities that would not be covered does not address the concern that RCRA standards are required to be stronger than what EPA proposed; if stronger standards had been developed, they would have applied to all facilities in order to achieve the same level of protection at all facilities.

- The practical problems of permitting these facilities are not a sufficient reason for such exemption; had Congress intended an exemption for these facilities not already needing a permit, it would have done so.

- The EPA should obtain the data it needs on the implications of the rule on small quantity generators and small businesses; the commenter fails to see how the need for obtaining data for certain reclamation processes justifies creating an exemption for all facilities that are not currently subject to permit requirements.

Response: The facilities of concern to the commenters are those that do not require a RCRA permit to operate. The EPA is promulgating these standards under the authority of Section 3004(n). Therefore, the standards only apply to facilities that need authorization under Section 3005 of RCRA to operate; i.e., the permitted community is not being expanded to incorporate the air emission regulations. However, facilities that do not need a RCRA permit have not been "exempted." They are simply not covered under this rulemaking. The EPA will continue to assess the need to develop air emission standards under the CAA for these facilities.

In considering the regulation of air emissions under RCRA Section 3004(n) and within the RCRA regulatory framework, EPA has concluded that air emissions from hazardous waste management units that are subject to RCRA Subtitle C should be regulated under the authority of RCRA Section 3004(n). Air emissions from hazardous wastes from facilities or units that manage solid wastes that are not regulated as hazardous wastes pursuant to 40 CFR 261 (e.g., cement kiln dust waste) and air emissions from hazardous waste from units or facilities that are exempt from the permitting provisions of 40 CFR 270.1(c)(2) (e.g., wastewater treatment units with National Pollutant Discharge Elimination System permits) will be subject to control technique guidelines or standards developed as needed under either the CAA or RCRA authority. Air emissions from wastes managed in units subject to Subtitle D (nonhazardous solid wastes, such as those managed in municipal landfills) also will be subject to guidance or standards issued under CAA or RCRA authority, as appropriate.

3.1.4 Pollutants

Comment: Commenter AESP-L0018 questions why the proposed standards do not cover other pollutants, such as emissions from volatile metals.

Response: The standards do cover emissions of organometallics if they are contained in the waste stream and emitted from affected vents on distillation units, fractionation units, thin-film evaporators, solvent extraction units, steam and air strippers, or from equipment leaks. However, emissions of volatile metals can occur in other types of processes not covered by these rules. The additional TSDF air standards currently under development will apply to organic emissions from open and closed (covered) hazardous waste management units and are scheduled for proposal in late 1989 or early 1990.

Air standards also have been developed for the control of organic air emissions from permitted hazardous waste incinerators (40 CFR 264, Subpart O). These standards require that incinerators be operated to achieve a destruction and removal efficiency (DRE) of at least 99.99 percent for those primary organic hazardous constituents listed in the facility permit. Higher efficiencies are required when the incinerator is burning certain specified waste types. These standards also limited air emissions of organics, hydrochloric acid, and particulates from incinerator stacks. Air standards for interim status hazardous waste incinerators (40 CFR 265, Subpart O) require monitoring of visible emissions and operating conditions. When burning specified wastes, these incinerators must receive a certification from the Assistant Administrator stating that the incinerator can meet the performance standards specified for permitted incinerators in 40 CFR 264, Subpart O. Interim status standards to control air emissions for other thermal treatment units are found in 40 CFR 265, Subpart P. These standards apply to facilities that thermally treat hazardous waste in devices other than enclosed devices using controlled flame combustion. The standards require monitoring of visible emissions and operating conditions of the combustion devices and prohibit open burning except for open burning and detonation of waste explosives.

The Agency has also proposed standards covering the burning of hazardous waste in boilers and industrial furnaces (52 FR 16987, May 6, 1987). These standards would require such burning to achieve a DRE of 99.99 percent for each principal organic hazardous constituent identified in the facility permit. In addition, a DRE of 99.9999 percent must be achieved when burning certain specified constituents. The proposed standards also have provisions for burning low-risk wastes that allow an owner or operator to demonstrate that the burning of hazardous waste will not result in significant adverse health effects. To qualify for the low-risk waste exemption, an owner or operator would have to use emission modeling to demonstrate that emissions of carcinogenic compounds would not result in offsite ground-level concentrations that pose a risk to the most exposed individual of greater than 1 x 10^{-5}. For noncarcinogenic compounds, the emission modeling would demonstrate that the resulting air concentrations would not exceed the reference air concentration (RAC) of individual hazardous compounds. The standards proposed also would limit emissions of carbon monoxide, metals, and hydrochloric acid from boilers and furnaces burning hazardous wastes.

Volatile metals also can be emitted in the form of particulates. Standards that regulate particulate emissions from TSDF sources have been promulgated in 40 CFR 264 (40 CFR 264.251(f), 264.301(i), and 264.273(f)). The general standards require the implementation of design and operating practices at RCRA-permitted wastepiles, landfills, and land treatment operations to limit the release of particulate air emissions. As a separate effort, EPA has prepared a technical guidance document to aid in implementation of these standards. The document ("Hazardous Waste TSDF-Fugitive Particulate Matter Air Emissions Guidance Document," EPA-450/3-89-019) includes guidance on how to estimate particulate emissions from TSDF sources, how to assess the health risk associated with these emissions, and what controls are available to reduce particulate emissions and their health risks.

Additionally, 40 CFR 264 Subpart X contains provisions that require prevention of air releases that may have adverse effects on human health or the environment at miscellaneous hazardous waste management units.

3.1.5 Equipment and Sources

3.1.5.1 Definition of "Process Vent." Comment: Several commenters asked for clarification of the definition of "process vent" as follows: (1) to state whether a control device is needed on a condenser vent because the vent is in VHAP service if the condenser vent stream is greater than 10-percent total organic carbon (TOC) (the commenter does not believe control of condenser vents is intended and suggests drafting the definition and standard in terms of requiring a 95-percent reduction of uncontrolled emissions from specific pieces of equipment [AESP-00024]); (2) to clarify that discharges to the atmosphere from unenclosed (uncovered) process vessels such as product accumulator vessels are excluded (AESP-00030); and (3) to clearly exclude storage tanks or fixed-roof tanks, blending tanks, and transfer facilities (AESP-00003 and AESP-00006).

Response: First, it should be noted that for clarity the term "in VHAP service" has been dropped from the promulgated regulations and the applicability has been more specifically defined. These regulations apply to process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operations that manage hazardous wastes with total organic concentrations of at least 10 ppmw. Therefore, an exhaust gas or vent stream from a condenser serving a distillation, fractionation, thin-film evaporation, solvent extraction, or stripping operation that manages hazardous wastes with organic concentrations of at least 10 ppmw is subject to the requirements of these regulations. Total facility process vent emissions must be controlled to less than 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) or the owner/operator must install a control device(s) that reduces total organic emissions from all affected vents at the facility by 95 weight percent or, for enclosed combustion devices, to a total organic compound concentration of 20 ppmv. For the purpose of determining the 95 percent emission reduction performance requirement, primary condensers (i.e., those condensers whose primary function is the recovery of product for commercial recycling, sale, or reuse) are considered as process equipment and are not considered a control device in the performance calculations.

The final standard for process vents has been clarified since proposal to exclude air emissions from vents on other closed (covered) and vented tanks not associated with the specified distillation/separation processes. Thus, the final process vent standards apply to (1) process vents on distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping operations and vents on condensers serving these operations, and (2) process vents on tanks or vessels (e.g., distillate receivers, bottoms receivers, surge control tanks, separator tanks, and hot wells associated with distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping processes) if emissions from these operations are vented through the tank. For example, uncondensed overhead emitted from a distillate receiver (i.e., a tank) serving a hazardous waste distillation process unit is subject to air controls under these regulations. On the other hand, if emissions from the distillation unit or a condenser serving the unit are not vented through the tank (i.e., they are vented directly to the atmosphere or through a vacuum pump), then vent(s) that may be present on the tank are not subject to the final standard for process vents. Unenclosed or uncovered processes, storage tanks, fixed-roof tanks, and transfer facilities are not covered by these regulations, but they will be covered by the additional TSDF air emission standards scheduled for proposal in mid-1990.

3.1.5.2 Definition of "Facility." Comment: Commenter AESP-00007 disagrees with two of the examples provided in the preamble (52 FR 3754) regarding the types of facilities to be regulated. He does not agree with example 2b that would automatically apply the standards because an interim status or Part B permit is required for solvent storage prior to distillation and because this application does not recognize the difference between small onsite reclamation operations and large offsite operations.

Commenter AESP-00007 also disagrees with example 2c based on EPA's definition of "facility." The commenter does not believe that distillation operations should be subject to the standards merely because of the existence of a hazardous waste management unit requiring a RCRA permit. If the organic emission requirements are to be applied to onsite recycling, according to the commenter, they should apply only if the unit on the same site requires a permit and has as its intended purpose the treatment, storage, or disposal (TSD) of the hazardous solvents that are processed in the distillation operation. In support, the commenter cites EPA's definition of "facility" under 40 CFR 260.10 that excludes portions of TSDF property not used for hazardous waste TSD from RCRA and corrective action requirements.

Commenters AESP-00015 and AESP-L0010 also recommend that EPA modify the terminology of the proposed standards so as not to inadvertently apply the Agency's current interpretation of the term "facility"; if the terminology is not modified, then industrial operations such as paint spray booths or organic emissions from all materials, tanks, and waste handling equipment on the entire site (in these cases, military bases) would be subject to the standards.

Response: In response to Commenter AESP-00007, in promulgating these regulations under Section 3004(n), it is clearly within EPA's legal authority to issue air emission standards that apply to any unit that treats, stores, or disposes of hazardous wastes, regardless of whether the facility contains other units that also treat, store, or dispose of hazardous wastes. The EPA has determined that, as a matter of regulatory policy, it would be best to address under the CAA those units that are located at facilities that do not otherwise need a RCRA permit. However, this policy decision does not preclude EPA from regulating under RCRA any TSD unit located at a facility containing another TSD unit that requires a permit. In this context, the term "facility" retains its traditional definition set forth in 40 CFR 260.10.

In the preamble to the hazardous waste management system, final codification rule (50 FR 28702, July 15, 1985), EPA elaborated on the facility definition. The preamble states that:

> [The] EPA must assume that in using the term "facility," Congress intended, in the absence of contrary statutory language or legislative history, to adopt the definition of this term traditionally employed by the Agency. The preamble to the July 26, 1982, regulation elaborates on the definition of this term. Specifically, the preamble notes that "[w]hen using the term 'facility,' EPA is referring to the broadest extent of EPA's area jurisdiction under Section 3004 of RCRA... [meaning] the entire site that is under the control of the owner or operator engaged in hazardous waste management," 47 FR 32288-9 (July 26, 1982). The legislative history of the conference bill makes it clear that Congress was aware of the Agency's definition. In discussing new Section 3004(v) (see subsection e, infra), the Congress noted EPA's position limiting the scope of its remedial authorities to the property of the polluting facility. 130 Cong. Rec. H11129 (daily ed. Oct. 3, 1984). Accordingly, for purposes of Section 3004(a), the term "facility" is not limited to those portions of the owner's property at which units for the management of solid or hazardous waste are located, but rather extends to all contiguous property under the owner or operator's control.

This facility definition was upheld by the United States Court of Appeals for the District of Columbia Circuit (see United Technologies Corp. v. EPA, F. 2d [D.C. Cir. 1987]). Under this definition, a solvent reclaim operation and surface impoundment unit, for example, may often be considered to be part of a single facility. If they are part of the same facility, then the reclaim operation is subject to the Section 3004(n) regulations (provided that all other regulatory prerequisites are met).

With regard to the concerns of Commenters AESP-00015 and AESP-L0010, the Subparts AA and BB regulations apply to process vents and equipment, respectively, associated with hazardous waste management. Subpart BB air emission standards apply to owners and operators of equipment if it contains or contacts hazardous waste with organic concentrations at least

10 percent by weight. A process vent is subject to Subpart AA requirements if it is associated with distillation, fractionation, thin-film evaporation, or solvent extraction, or with air or steam stripping operations that manage hazardous wastes with organic concentrations of at least 10 ppmw. Therefore, organic emissions from vents from industrial operations not associated with hazardous waste management, such as paint spray booths or product distillation columns, are not subject to these rules. However, organic emissions from affected process vents anywhere on the entire facility (provided the facility requires a permit under 40 CFR 270 due to other hazardous waste activity at the facility) are subject to the standards. Similarly, organic emissions from affected equipment anywhere on the entire facility (provided a RCRA permit is required under 40 CFR 270 due to other hazardous waste activity at the facility) are subject to the standards.

3.1.5.3 Fugitive Sources. Comment: Commenter AESP-L0015 asks if pumps or valves for organic liquids at a hazardous waste incinerator are subject to the equipment leak standards, and if so, is it according to the 40 CFR 60 or the 40 CFR 61 requirements. Commenter AESP-00024 points out that all components such as pumps, flanges, and valves associated with hazardous waste tanks are required to be inspected on a daily basis under 40 CFR 264.195. If a visual leak is detected, the component must be taken out of service. The commenter believes this is more than adequate for equipment in heavy-liquid service and should be the only standards required for fugitive emission control.

Response: In response to Commenter AESP-L0015, pumps and valves containing or contacting hazardous wastes with at least 10 percent organic concentrations at a hazardous waste incinerator are subject to the standards. Specifically, the applicable requirements include Section 264.1052 and Section 264.1057 for pumps in light-liquid service and valves in gas/vapor service or in light-liquid service, and Section 264.1058 for pumps and valves in heavy-liquid service, pressure relief devices in light-liquid or heavy-liquid service, and flanges and other connectors.

The visual inspections required for pumps, valves, and flanges referred to by Commenter AESP-00024 are associated with ground-water protection rules and by themselves are not appropriate or adequate for monitoring air emissions. Whereas an operator can make a visual inspection to ensure that no liquids are dripping onto the ground, air emissions cannot be detected as easily. In addition, the commenter states that these inspection rules are for equipment in heavy-liquid service. However, most air emissions from equipment leaks are from equipment in light-liquid service. The response to comment 11.4.2 contains suggestions as to potential ways operators may be able to combine monitoring efforts to reduce duplication of labor and recordkeeping/reporting provisions.

3.1.5.4 Definition of "Product Accumulator Vessel" (PAV). Numerous comments were made on the definition of "product accumulator vessel" that requested clarification of the intended scope of equipment covered under the definition. The promulgated standards cover process vents and equipment associated with the handling and management of hazardous waste.

Comment: The EPA should confirm that coverage excludes open tanks and is limited to PAVs used for treating waste solvents that are currently enclosed and vented by means of pipes or stacks so as not to be interpreted that all PAVs must be equipped with a closed-vent system that captures and transports emissions to a 95-percent control device (AESP-L0005, AESP-00030, and AESP-00017).

Response: With respect to the comments concerning open tanks, the proposal preamble states at 52 FR 3753 that "the standards apply only to the specifically enumerated types of equipment. Devices such as...open tanks would not be 'equipment' for purposes of today's rule and so would not be covered by today's proposal." The same is true under the final rules.

Comment: Are recovered material storage tanks, hazardous waste storage tanks, or other types of storage tanks covered by the rules (AESP-L0006, AESP-L0007, AESP-L0011, AESP-00033, AESP-00006, and AESP-00014)? Also, Commenter AESP-00024 asks if all hazardous waste accumulation tanks are covered by the rules if they are associated with a VHAP hazardous waste and the facility has an interim status or Part B (final) permit for any reason. Are a tank and associated equipment that vent to the atmosphere during loading or due to breathing losses covered since this is not venting by mechanical or process-related means (AESP-00022)?

Response: In the promulgated rule, the applicability of the process vent provisions has been more precisely defined in terms of the types of emissions and emission sources covered. A tank vent is covered only if process emissions from distillation, fractionation, thin-film evaporation, solvent extraction, or steam or air stripping operations managing hazardous wastes with organic concentrations of at least 10 ppmw on an annual average basis, are vented through the tank (e.g., distillate receiver, condenser, bottoms receiver, surge control tank, separator tank, or hot well) associated with one of these operations. Vented means that the passage of liquids, gases, or fumes is caused by mechanical means such as compressors or vacuum-producing systems or by process-related means such as evaporation produced by heating and not caused by tank loading and unloading (working losses) or by natural means such as diurnal temperature changes. A tank vent that discharges process emissions as defined above is subject to the process vent final rules.

Regarding storage tanks, the passage of liquids, gases, or fumes from the tank vent must be caused by mechanical means or process-related means and not by natural means such as diurnal temperature changes. Therefore, a storage tank is not covered by this rule unless process emissions associated with the specified processes are vented through it. The definition of venting cited above also applies in response to the question of Commenter AESP-00022 concerning whether equipment that vent during loading or due to breathing losses are covered. Loading and breathing losses are not caused by mechanical or process-related means such as by heating in distillation processes, and hence, are not covered by this rule.

Comment: If, as stated in the proposal preamble, the product storage exemption is not affected by the control of process accumulator vessels, then such units as product distillation columns generating organic hazardous waste still bottoms over 10 percent total organics would not be subject to the standards while they are in the distillation column unit. If the still bottoms are not considered to be a hazardous waste while in the distillation column, then the column is not in VHAP service and not subject to the proposed standards (AESP-L0006).

Response: With regard to the product storage exemption, paragraph 261.4(c) of the RCRA regulations exempts from regulation hazardous wastes that are generated (emphasis added) in process-related equipment such as product or raw material storage tanks, or product or raw material pipelines. This exemption applies until the waste is physically removed from the unit in which it was generated, unless the unit is a surface impoundment or unless the hazardous waste remains in the unit more than 90 days after the unit ceases to be operated for manufacturing, or for storage or transportation of product or raw materials. This exemption is not affected by the final rule; therefore, units such as product (emphasis added) distillation columns generating organic hazardous waste still bottoms containing greater than 10 ppmw organics would not be subject to this regulation while the wastes are in the distillation column unit. However, distillation columns that receive hazardous wastes and are used in the hazardous waste treatment are covered by this regulation. It also should be noted that RCRA authority does not extend to equipment handling commercial product; dropping the term "product accumulator vessel" should help clarify this point.

Comment: There are contradictions in the regulation and the preamble regarding PAVs. The preamble refers to PAV as types of equipment that generate process emissions such as process vents, distillate receivers, surge control vessels, product separators, or hot wells (52 FR 3753) and at other points as units used to steam strip or air strip volatile components from hazardous waste (52 FR 3749) or as "most distillation columns" (52 FR 3753) (AESP-L0006).

Response: The wording of the proposal preamble and the proposed rule inadvertently led to confusion concerning the scope of the standards. For clarity, the term "product accumulator vessel" has been dropped from the standards.

Comment: The preamble at 52 FR 3762 states that "...recovery devices such as steam strippers treating organic-rich hazardous wastes that would otherwise qualify for the wastewater treatment exemption are not covered by today's rule"; by this reasoning, air strippers in wastewater service would be exempt and so would distillation columns and air and steam strippers (AESP-L0006).

Response: Paragraphs 264.1(g)(6) and 265.1(c)(9) exempt wastewater treatment tanks and elementary neutralization units (defined in 40 CFR 260.10) from the Subtitle C regulation. The scope of that exemption is not affected by this regulation. Therefore, exempted recovery devices such as air strippers, steam strippers, or distillation columns that are regulated under either Section 402 or 307(b) of the Clean Water Act (CWA) are not covered by this rule. However, air emission sources that are not controlled under RCRA may still be covered under the CAA.

Comment: Does the 90-day accumulation exemption apply to tanks that have 100 percent flowthrough (AESP-L0001)?

Response: As noted in the proposal preamble, 40 CFR 262.34 of RCRA states that generator (emphasis added) tanks that accumulate hazardous waste for 90 days or less are not subject to interim status or final permit standards, provided they comply with most of the substantive standards for tanks storing hazardous wastes. Therefore, the promulgated standards do not apply to generator tanks that accumulate hazardous waste for 90 days or less. The exemption for 90-day storage is discussed in the response to comment 4.5.

Comment: The commenter asked EPA to clarify the closed-loop tank exemption in the definition of solid waste; the commenter also asked whether distillation columns (which have constant flowthrough and do not accumulate) meet the definition of tank (i.e., distillation columns are not tanks and application of standards to them is incorrect) (AESP-L0001).

Response: The final rules regulate the activity of reclamation at certain types of RCRA facilities for the first time. The EPA is amending 40 CFR 261.6 under its RCRA authority over reclamation to allow covering reclamation of hazardous wastes in waste management units affected by the final rules for process vents and equipment leaks. It should be recognized, however, that these final rules apply only at facilities otherwise needing a RCRA permit. In addition, the closed-loop reclamation in Part 261.4(a)(8) is not changed by these rules. Therefore, not all reclamation units will necessarily be affected by these rules.

In response to a court opinion (American Mining Congress v. EPA, 824 F.2d 1177, D.C. Circuit Court of Appeals, July 31, 1987) concerning the scope of EPA's RCRA authority, EPA proposed amendments to the RCRA definition of "solid waste" that would clarify when reclamation operations can be considered to be managing solid and hazardous wastes (53 FR 519, January 8, 1988). The EPA has accepted comments on its interpretation and proposed amendments. The EPA has not yet taken final action on this proposal. Thus, EPA is addressing the scope of its authority over reclamation operations under RCRA in the context of that rulemaking. The process vent rule is based on EPA's current interpretation of its RCRA authority, as described in the January 1988 proposal.

The following summarizes EPA's proposed position. In general, the proposed amendments would exclude from RCRA control only those spent solvents reclaimed as part of a continuous, ongoing manufacturing process where the material to be reclaimed is piped (or moved by a comparably closed means of conveyance) to a reclamation device, any storage preceding reclamation is in a tank, and the material is returned, after being reclaimed, to the original process where it was generated. (Other conditions on this exclusion relate to duration and purpose of the reclamation process. See proposed Section 261.4[a][8].)

However, processes (or other types of recycling) involving an element of "discard" are (or can be) within RCRA Subtitle C authority. When spent materials are being reclaimed, this element of discard can arise in two principal ways. First, when spent materials are reclaimed by someone other than the generator, normally in an off-site operation, the generator of the spent material is getting rid of the material and so is discarding it. In addition, the spent material itself, by definition, is used up and unfit for further direct use; the spent material must first be restored to a usable condition. This type of operation has been characterized by some of the worst environmental damage incidents involving recycling (50 FR 658-661, January 4, 1985). Moreover, storage preceding such reclamation has been subject to the Part 264 and 265 standards since November 19, 1980. (See generally 53 FR 522 and underlying record materials.) The American Mining Congress opinion itself indicates that such materials are solid wastes (824 F.2d at 1187).

When a spent material is reclaimed on-site in something other than a closed-loop process, EPA also considers that the spent material is discarded (i.e., spent solvents removed from the process, transferred to an on-site distillation unit, and regenerated have been removed from the production process). The EPA's reasoning is that these materials are no longer available for use in an ongoing process and have been disposed from that operation, even if the reclamation operation is on-site. Finally, EPA also considers that when hazardous secondary materials are reclaimed but then burned as fuels, the entire operation--culminating in thermal combustion--constitutes discarding via destructive combustion (53 FR 523). Consequently, under this reading, any intermediate reclamation step in these types of fuel production operations remains within EPA's Subtitle C authority.

In summary, under EPA's current interpretation of the court's opinion, air emissions from distillation, fractionation, thin-film evaporation, solvent extraction, and stripping processes involving reclamation of spent solvent and other spent hazardous secondary materials can be regulated under RCRA Subtitle C whenever the reclamation system is not part of the type of closed-loop reclamation system described in proposed Part 261.4(a)(8). Any changes to this interpretation as part of the solid waste definition final rule may affect the scope of this rule.

Comment: The EPA should remove "condenser" from the PAV definition because a primary or secondary condenser may be installed to meet the standard but also be a source for control and it is difficult to differentiate a process condenser vent from a control device condenser vent for determining compliance; the commenters suggest replacing reference to condenser with "control device" and by expressing the standard in terms of uncontrolled emissions from specific equipment (AESP-00024 and AESP-00034).

Response: With respect to the commenters' concerns about differentiating between a process condenser vent and a control device condenser vent, for determining compliance, the primary condenser is considered a component of the process (i.e., the primary function is the commerical recovery of product), and any additional vent condenser is considered a control device. This distinction is important in determining the required 95-percent facility process vent emission reduction for facilities that cannot achieve the process vent emission rate cutoff.

Comment: The EPA needs to give examples of equipment covered (AESP-00020), to clarify sources in the chemical plants and petroleum refineries that would be newly regulated (AESP-00010), and to clarify the specific units covered so that EPA only regulates units for which sufficient supporting information is available (AESP-00013).

Response: The process vent standards apply to vents emitting organic liquids, gases, or fumes that are associated with hazardous waste management units treating wastes with a 10 ppmw or greater total organics concentration and are specific to: (1) process vents on distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping operations and vents on condensers serving these operations, and (2) process vents on tanks (e.g., distillate receivers, bottoms receivers, surge control tanks, separator tanks, and hot wells) associated with distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping processes if emissions from these process operations are vented through the tank. For example, uncondensed overhead emitted from a distillate receiver (which fits the definition of a tank) serving a hazardous waste distillation process unit is subject to air controls. Emissions from vents on tanks or containers that do not derive from a process unit specified above are not covered by these rules. For example, if the condensed (recovered) solvent is pumped to an intermediate holding tank following the distillate receiver mentioned in the above example, and the intermediate storage tank has a pressure relief vent (e.g., a conservation vent) serving the tank, this vent will not be subject to the process vent standards. Emissions from vents that are not covered under today's rules will be regulated by other air standards developed under 3004(n) of RCRA.

3.1.5.5 Other TSDF Sources. Comment: Commenters AESP-L0016 and AESP-00019 ask why the proposed standards do not cover other TSDF sources such as open tanks, waste solvent piping, storage, and transfer operations. Commenter AESP-00004 states that open air sources, not solvent refining, should be the focus of regulatory concern. Commenter AESP-00006 recommends that the regulations should be clarified to include or exclude storage tanks, blending tanks, and transfer facilities at TSDF. Five commenters (AESP-L0018, AESP-L0016, AESP-00014, AESP-00008, and AESP-00019) also question why the proposed standards apply to closed tanks, but not to open tanks (including storage vessels) per Congressional intention under Section 3004(n). The commenters state that the levels of emissions from vents and fugitive releases from these sources are far higher than from equipment leaks, particularly when the materials stored have high vapor pressures or are filled and emptied routinely. They point out that excluding open tanks is unjustified environmentally and unfair to those TSDF that already have installed controls. Excluding open tanks also will undercut the proposed rules because many TSDF will switch to open tanks to avoid control. In comparision, one commenter (AESP-L0003) submits that the 1981 national emission standard for hazardous air pollutants (NESHAP) for benzene storage tanks was not promulgated because the cost of controls greatly exceeded the benefit and that similiar controls on TSDF storage tanks would also fail a cost-benefit evaluation.

Response: As previously stated, other TSDF sources mentioned by the commenters are being studied under the additional Section 3004(n) air emission rules scheduled for proposal in late 1989. Treatment and storage tanks, surface impoundments, and containers are among the sources that will be covered under these rules.

The EPA agrees that storage tanks are a significant source of emissions at TSDF. Preliminary estimates presented in TSDF BID Volume I (Docket No. F-90-AESF-FFFFF, item S0042) indicate that nationwide uncontrolled organic emissions from TSDF storage tanks may be as high as 756,000 Mg/yr (838,000 ton/yr). As discussed in response to comment 3.2.3, whether or not such standards would fail a cost-benefit evaluation is not germane under RCRA. Finally, the benzene storage proposal was withdrawn only on the basis that the risks did not warrant Federal regulation under the CAA.

3.2 STATUTORY AUTHORITY AND REGULATORY APPROACH

3.2.1 RCRA vs. the CAA

Comment: A total of 22 commenters recommend that the CAA is the proper statutory authority and regulatory mechanism for the standards rather than RCRA. They point out that volatile organic (VO) emissions and ozone are the province of CAA programs, including: (1) National Emission Standards for Hazardous Air Pollutants (NESHAP), NSPS, prevention of significant deterioriation (PSD), and State implementation plans (SIP). Specific regulations such as the NSPS for fugitive emissions from the SOCMI and regulations under development such as the NSPS for volatile organic liquid (VOL) storage, the SOCMI distillation NSPS, and the hazardous organic NESHAP (HON) address the processes and chemicals (including intermediates and products) likely to require fugitive or process controls at new or existing TSDF or WSTF. Several commenters also point out that these standards would not allow the construction or expansion of recycling operations without emission controls.

Many commenters state that the proposed standards are duplicative of these CAA programs. For example, several commenters explain that they are subject to State or local reasonably available control technology (RACT) controls in ozone nonattainment areas under Section 172 of the CAA. Commenter AESP-L0025 provides information showing that using 95-percent control with RACT provides a better emission reduction in most cases and yields control of noncarcinogens based on the physical properties of the compounds. Commenter AESP-L0003 states that, by adding redundant regulations inconsistent with existing CAA standards, the Agency is fragmenting its rules and making them more confusing to the regulated community; Commenter AESP-00019 points out that Section 1006(b) of RCRA provides that regulations should avoid duplication to the extent possible with the CAA. The commenters also state that the CAA already has a regulatory structure in place to address hazardous air emissions for specific organic chemicals on a risk priority basis that considers the relative toxicities and differing physical characteristics of the chemicals. According to the commenters, the objectives of Section 112 of the CAA and RCRA Section 3004(n) are identical in protection of public health and the environment, and it is more appropriate for EPA to extend existing CAA standards to TSDF than to devise duplicative approaches under RCRA (AESP-00024, AESP-L0007, AESP-L0003, AESP-L0001, AESP-00029, AESP-00033, AESP-00007, AESP-00010, AESP-L0006, AESP-00019, AESP-00016, AESP-00025, AESP-00027, AESP-00028, AESP-00030, AESP-00031, AESP-00035, AESP-L0025, AESP-00004, AESP-00002, AESP-00023, and AESP-00017).

Response: Both RCRA and the CAA authorize EPA to require monitoring and control of air emissions at TSDF. Section 3004 is not limited to certain media, although EPA regulations have focused on preventing the contamination of soil and water. Indeed, Section 3004(n) specifically commands EPA to issue regulations controlling air emissions from TSDF. There is no indication that Congress intended that all air regulations be issued within the confines of the CAA. On the contrary, when adding Section 3004(n), Congress specifically recognized EPA's dual authority to regulate these air pollutants (S. Rep. 98-284 page 63). As described below, EPA has conducted an analysis of current State and Federal controls and concluded that further regulation under Section 3004(n) of RCRA is necessary to protect human health and the environment.

In response to the commenters' concerns, EPA examined State and Federal regulations, including CAA SIP requirements, to determine the potential for overlapping rules and duplicative permitting (Docket No. F-90-AESF-FFFFF, item S0016). In general, the SIP contain strategies for obtaining greater VOC emission reductions, particularly in the 37 States with ozone nonattainment areas. Under this CAA strategy, any new or modified source with the potential to emit over 40 ton/yr of uncontrolled

VOC emissions must obtain a permit to operate. Because control technique guidelines (CTG) are not available for TSDF, many States have applied the CTG for VOC leaks from synthetic organic chemical and polymer manufacturing equipment (EPA-450/3-83-006, March 1984) and/or extended other CAA standards such as the NSPS for VOC emissions from petroleum refineries or for SOCMI. A total of 6 States have established air toxics programs that would apply to TSDF, and an estimated 60 additional States and localities currently are in the process of developing such air toxics programs. Moreover, a total of 21 States have established generic standards for VOC sources or processes that are separate from Federal NSPS, national emission standards, ambient standards, and CTG programs. These regulations primarily affect non-CTG sources of VOC emissions such as process vents, VOC water separators, equipment leaks, and vapor blowdown systems.

Because the standards vary widely in scope and application, it is not possible to quantify a typical baseline level of control. However, in most cases, it appears that, while CAA permits to operate have been issued for process vents at onsite and offsite TSDF and perhaps have been incorporated in the RCRA permitting process, controls generally are not required for these significant organic emission sources. For example, several respondents to EPA Section 3007 questionnaires that were sent to a limited number of TSDF reported requirements for air contaminant source operating permits, but they indicated no permit requirements for controlling process vent emissions. The nonuniformity among the States in applying organic emission controls at TSDF supports the Agency's view that nationwide standards are needed.

The potential effect on waste solvent treatment facilities of Federal standards currently under development also was examined. In this regard, EPA reviewed such actions as the proposed NSPS for SOCMI distillation operations (48 FR 57538, December 30, 1983), the HON under development, and potential listing decisions under Section 112. The SOCMI NSPS, if promulgated, would control VOC emissions from condensers, accumulators, hot wells, steam jet ejectors, vacuum pumps, and pressure relief valves on new, modified, or reconstructed fractional distillation units at organic chemical manufacturing plants. Existing units at SOCMI plants would not be covered by the NSPS, nor would distillation units used for recycling in many of the 150 other industries with onsite TSDF or at commercial facilities. As noted in the EPA Semiannual Regulatory Agenda at 52 FR 40903 (October 26, 1987), new issues have arisen in this SOCMI rulemaking, and the Agency is deciding whether to promulgate these standards. The potential overlap of the HON also was cited by several commenters in support of promulgating these standards under the CAA. Although still under development, this project would govern emissions of butadiene, carbon tetrachloride, chloroform, ethylene dichloride, ethylene oxide, methylene chloride, perchloroethylene, and trichloroethylene from process vents, equipment leaks, and storage facilities. Regulated source categories would include facilities used to produce butadiene, chlorinated hydrocarbons, chlorine, chlorofluorocarbons, ethylene dichloride, ethylene chloride, neoprene, pesticides, pharmaceuticals, polybutadiene, and stryene butadiene rubber, as well as chlorinated hydrocarbons used in chemical production. It is estimated that the rule would cover about 5 percent of the SOCMI's total production, or between 120 and 150 individual processing units. The air controls under consideration for these process sources (and not for waste treatment sources) would be similar to those already required under the benzene fugitive standards. Thus, EPA does not believe that these standards for air emissions from waste treatment sources are duplicative of NSPS or NESHAP programs under development.

3.2.2 Level of Control Under RCRA

Comment: Commenter AESP-L0016 criticizes the level of control selected for the proposed standards as not meeting the mandate of RCRA Section 3004(n) for two major reasons: (1) the standards are protective in most, but not all cases (further protection is needed in the form of enforceable regulations and not through the imposition of more stringent controls by permit writers); and (2) the standards are inconsistent with Section 3004(m) that requires treatment standards based on BDAT. On the latter point, the commenter argues that the proposed air rules also must be based on BDAT (or the most effective techniques that are available), but instead employ inadequately stringent controls despite the fact that more effective techniques are applicable and available.

Response: The question of whether these standards implement the requirements of RCRA Section 3004(m) is irrelevant. Regulations implementing Section 3004(m), which is a pretreatment-based program that defines when hazardous wastes can be land disposed, have been (and will continue to be) separately promulgated by EPA. For example, see 51 FR 40636 (November 7, 1986) and 52 FR 25787 (July 8, 1987). Today's regulations are promulgated as a first step in implementing Section 3004(n) of RCRA, which requires that the regulations be those that are necessary to protect human health and the environment. Therefore, in developing today's rule, EPA has focused on achieving acceptable levels of health and environmental protection, rather than on meeting a certain treatment level.

Moreover, as stated in other responses to comments, EPA is developing additional standards beyond those promulgated today for other emission sources and for particular constituents that may pose unacceptable risk after implementation of these and the additional TSDF regulations. To fully address the health and environmental effects of TSDF air emissions, the wide variety of sources, and the need for different data with increasingly complex analyses, EPA has developed a multiphased standards development approach for regulating TSDF organic air emissions. This approach is described below.

The EPA has determined that organic emissions from TSDF managing hazardous wastes increase cancer risks and contribute to ambient ozone formation. Phases I and II of the TSDF emission standards approach will significantly reduce emissions of air toxics and carcinogens, and ozone precursors by controlling emissions of organics as a class rather than controlling emissions of individual waste constituents. The regulation of organics as a class has the advantage of being relatively straightforward because it can be accomplished with the minimum number of standards, whereas the control of individual toxic constituents will require multiple standards. Regulating organics as a class also makes efficient use of EPA resources, avoids many of the complexities of having multiple standards, and reduces the number of constituents for which separate standards ultimately will be required.

The health and environmental effects of ambient ozone are well documented and, in terms of monetary losses, they total hundreds of millions of dollars each year. Health impacts of TSDF organic emissions are discussed in this BID and in the draft BID for Phase II organic standards titled "Hazardous Waste TSDF - Background Information for Proposed RCRA Air Emission Standards," available in Docket F-90-CESP-FFFFF. The substantial reductions in organic emissions achievable through implementation of

Phase I and Phase II controls will reduce atmospheric ozone formation as a result of reductions in TSDF emissions of ozone precursors and will reduce nationwide cancer incidence and maximum individual risk due to exposure to air toxics and carcinogens emitted from TSDF.

Specifically, Phase I entails the promulgation of standards for the control of organic air emissions from selected hazardous waste management processes and equipment leaks. Publication of final rules for air emissions from hazardous waste management process vents from distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping processes and from leaks in piping and associated equipment handling hazardous wastes marks the completion of this first stage.

Like the process vent and equipment leak standards, the standards developed under Phase II will control organic air emissions as a class. In the second stage, EPA will propose to extend standards (in mid-1990) under Section 3004(n) to include organic air emissions from other significant TSDF air emission sources not covered or not adequately controlled by existing standards. Those sources include surface impoundments, storage and treatment tanks (including vents on closed, vented tanks), containers, and miscellaneous units.

Under Phase III of the program, EPA may develop additional standards applicable to sources regulated in the process vent and equipment leak rule, and to sources covered in Phase II. The Agency recognizes that the potential remains for high risk at some facilities because of individual chemical constituents or other physical characteristics of the facility even after the substantial emission reductions achieved through Phase I and II controls. For this reason, EPA will examine the need for standards for the control of emissions of specific hazardous waste constituents from all TSDF sources that may continue to pose a high health risk after the standards for organics are implemented. The constituents to be evaluated will include those reported as being present in hazardous wastes managed by existing TSDF for which health effects have been established through the development of unit risk factors for carcinogens and reference doses for noncarcinogens. General regulatory approaches that will be considered vary widely and range from requiring additional technology controls to limiting the quantities of specific constituents that can be managed at a TSDF. A more detailed discussion of Agency plans to address TSDF residual risk is presented in Section VIII of the preamble to the process vent and equipment leak rules. Because the development of these Phase III regulations will require more detailed analysis and the bulk of the TSDF air emission problems will be dealt with under Phases I and II, the Phase III rules will be proposed and promulgated after those developed in the first two phases.

The EPA has selected this multiphased approach, in part, because of the complexity of the TSDF industry and the considerable uncertainty in currently available data, particularly with regard to individual chemical constituent emissions and risk estimates. Industry surveys soon to be completed by the EPA are expected to provide detailed, up-to-date data on waste constituent concentrations, waste quantities, and processing locations needed to provide more accurate estimates of health impacts. These data will be fully reviewed and incorporated into emission and risk analyses prior to promulgation of the Phase II standards and proposal of Phase III standards.

3.2.3 Consideration of Costs

Comment: Five commenters question the role of costs as a RCRA decision factor. Commenter AESP-L0016 states that the proposed rule is in violation of RCRA for rejecting tighter controls because, according to the commenter, neither the statute nor the RCRA legislative history allows consideration of costs. In comparison, other commenters ask why costs and cost effectiveness were not more explicitly considered and why the risk/cost/benefit value of $35.3 million/yr cited at 52 FR 3765 of the preamble is higher than the cost-benefit level used by EPA in previous CAA control decisions (AESP-L0018, AESP-00034, AESP-00024, and AESP-00010).

Response: The role of costs as a decision criterion under RCRA in Subtitle C is not explicitly addressed in the statute. The Agency's position on this topic was discussed in 1980 when EPA established the basic Subtitle C regulatory framework (45 FR 33089, May 19, 1980). The EPA believes that it has the authority under RCRA Subtitle C to collect cost information for presentation to the Administrator and the public. The EPA also may consider costs as a basis for choosing between alternatives that are equally protective. However, under Subtitle C, EPA may not select controls or standards that do not adequately protect human health and the environment based on explicit consideration of costs. The EPA does not believe that the cost burden on industry is a basis for reducing the stringency of standards the agency considers necessary to protect human health and the environment.

Emission levels considered protective of human health and the environment on a nationwide basis were selected for both process vents and equipment leaks without regard to cost (see comments 7.1 and 7.6, respectively). Because the standards for process vents are performance-based, the standards do not specify how a facility owner or operator must meet the standards, but allow him to use whatever equipment he chooses as long as the standard is met. Cost impacts of the standard are estimated by EPA based on the least expensive means of control. Cost estimates were also developed to evaluate the economic impacts of the equipment leak standard only after a the control level was selected.

3.2.4 RCRA Section 3004(n)

Comment: Commenter AESP-L0006 questions EPA's authority under RCRA Section 3004(n) to propose controls for leaking equipment at TSDF because Congressional intention refers to major sources such as open tanks, surface impoundments, and landfills, and it is arguable, according to the commenter, that this authority extends to fugitive sources traditionally regulated under the CAA. Commenter AESP-00019 states that Section 3004(n) does not imply that WSTF should be regulated before other major TSDF sources.

Response: The EPA disagrees that Congressional intention under Section 3004(n) limits regulations to tanks, surface impoundments, and landfills. The section clearly specifies regulations "for the monitoring and control of air emissions at hazardous waste TSDF, including but not limited to open tanks, surface impoundments, and landfills, as may be necessary to protect human health and the environment" (emphasis added). The EPA believes that any source at a hazardous waste TSDF that endangers human health and the environment can, and should, be regulated under this authority. Uncontrolled fugitive emissions from WSTF and other TSDF equipment leaks are estimated to total about 26,000 Mg/yr (29,000 ton/yr) and result in an estimated 1.1 cases of cancer per year. The fact that equipment leak sources at TSDF are regulated before other sources is not germane to this issue. As discussed in response to comment 3.2.8, these standards preceded the additional Section 3004(n) air emission rules because much of the information needed to develop these standards was already available.

3.2.5 RCRA Authority to Control Reclaimed Commercial Product

Comment: Four commenters (AESP-00019, AESP-L0003, AESP-L0018, and AESP-L0025) question EPA's authority under RCRA to regulate equipment used to store and handle commercial product, such as distillate receivers. The commenters state that, while the CAA provides this authority, RCRA does not. Under 40 CFR 261.3(c)(2), commercial products reclaimed from hazardous wastes are products, not wastes; commercial products are not covered by Subtitle C regulations, and regenerated solvents are not wastes.

Response: The EPA agrees that commercial products are not covered under RCRA. Therefore, vents from tanks such as distillate receivers that emit organics derived only from the reclaimed products are not subject to the standard. However, if the distillation column overhead stream containing uncondensed organics from processing hazardous waste with a total organic concentration above the applicability criterion is vented to the atmosphere through a tank associated with the distillation operation, then the tank vent is subject to the requirements of the standard.

A more detailed discussion of EPA's authority to regulate reclamation (or regeneration) operations is presented in Section 3.1.5.4 of this BID.

3.2.6 Total Organics Approach

Comment: Numerous commenters contend that the proposed rules for process vents should be based on volatility and not their total organic content because the relative amount of organic content by weight does not determine its potential air emissions and subsequent health effects. They state that the definition of "VO" (1) should include only volatile organics instead of total organics; (2) should exclude ozone precursors to be consistent with the definition of "VOC" under the CAA and CAA State regulations, which specifically exclude methyl chloroform, methylene chloride, and CFC-113 because they are negligibly photochemically reactive; and (3) should be limited to known or suspected carcinogens listed in 40 CFR 261, Subpart D, that are volatiles. According to these commenters, it is inappropriate to lump thousands of RCRA hazardous chemicals together and assume that all should be controlled in the same manner because emissions and need for control depend on vapor pressure, solubility, heat content, corrosivity, and combustibility, as well as health effects. One commenter states specifically that EPA's proposed control of nonvolatile, nonhazardous pollutants is not authorized under risk-based Section 3004(n). (AESP-L0011,

AESP-00010, AESP-L0005, AESP-L0006, AESP-00011, AESP-00003, AESP-L0008, AESP-00018, AESP-00013, AESP-00030, AESP-L0003, AESP-L0001, AESP-00016, AESP-00019, AESP-00033, AESP-L0002, AESP-L0007, AESP-L0015, AESP-L0018, AESP-00035, AESP-00002, AESP-00034, AESP-00035, AESP-L0009, AESP-00017, and AESP-00024).

Response: First, it should be pointed out that EPA is concerned about ozone formation as well as cancer risk resulting from TSDF organic emissions. Ozone presents a threat to human health and the environment that warrants control under RCRA. The EPA agrees that total organic content may not be a completely accurate guage of potential environmental (e.g., ozone) or health (e.g., cancer) impacts for a source such as process vents, but it is a readily measurable indicator. In addition, the final rule's substantive control requirements do apply only to vents and equipment containing volatile components.

The final vent standard applies to certain process vents emitting organics, if the vent is associated with one of the process units specified in the rule and the unit manages a hazardous waste with at least 10 ppmw total organic concentration on an annual average basis. A process vent is determined to be affected by the standard if the vent is part of the hazardous waste distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping unit; this includes vents on tanks (e.g., distillate receivers or hot wells) serving the units if emissions from the process operations are vented through the tank. Total organic content of the process vent stream is not a consideration in determining process vent applicability. As public commenters pointed out, the 10-percent total organics process vent concentration cutoff does not limit total emissions or relate to emissions that escape capture by existing control devices and therefore was not included in the final rules.

Furthermore, the process vents covered by this rule are typically associated with distillation/separation processes used to recycle spent solvents and other organic chemicals. By definition, distillation is a process that consists of driving gas or vapor from liquids or solids by heating and then condensing the vapor(s) to liquid products. Wastes treated by distillation are expected to contain organics that are driven off in the process. Thus, by their nature, process vent emissions contain volatile organics.

The EPA agrees, however, that total organic content may not accurately describe the air emissions in terms of the potential impacts for a source such as process vents. Therefore, the total facility emission rate limit of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) below which additional, quantifiably significant risk reductions are not attained has been added to the final rule to exclude some facilities from the process vent emission reduction requirements. In determining the emission rate limit, emissions and health risks have been considered. (The cutoff determination is discussed in response to comment 7.1.)

As the commenters suggest, thousands of RCRA chemicals could be contained in various hazardous wastes treated by distillation and in hazardous wastes treated by WSTF. Developing and implementing regulations based on specific constituents would be needlessly cumbersome and complex. As described in Chapter 6.0, a range of unit risk factors was derived that represent the health risks of the hazardous constituents most frequently found in hazardous waste treated by WSTF. A midrange value of process vent constituent risk factors was used in evaluating the health risks associated with process vent emissions and in determining the cutoff. Compounds excluded by States in their definitions of VOC were not excluded because several are suspected carcinogens that currently are being studied by EPA.

Under the final standards, the term "organic emissions" is used in lieu of "volatile organic emissions" to avoid confusion with "volatile organic compounds (VOC)." As at proposal, the final rule applies to total organics. Because of the hundreds of hazardous constituents that could be contained in and contacted by the equipment covered by today's rules, the Agency recognizes the potential for risk at some facilities to remain higher than the residual risk for other standards promulgated under RCRA. Regulations based only on specific constituents will therefore be developed, as necessary, in Phase III of the Agency's regulatory approach. The constituents to be evaluated will include those reported as being present in hazardous wastes managed by existing TSDF for which health effects have been established through the development of unit risk factors for carcinogens and reference doses for noncarcinogens.

Similarly, in analyzing the technical feasibility of achieving 95-percent control efficiencies, compounds frequently recycled by WSTF were considered. Compounds used in evaluating control techniques (Docket No.

90-AESF-FFFFF, item S0047) include methyl ethyl ketone (MEK), methylene chloride, toluene, and 1,1,1 trichloroethane, which have properties representing the range of chemical and physical characteristics of recycled solvents. Chapter 7.0 of this document includes discussions of the technical feasibility of applying condensers and carbon adsorption systems to process vent streams to comply with the regulation.

Comment: Many comments also were received stating that the use of total organics is not appropriate for defining equipment "in VHAP service" because many of the organics at TSDF have low volatilities (they are collected at ambient conditions). Many find the definition confusing when compared to the established definition of "in VHAP service" under CAA standards because the CAA definitions generally are limited to specific chemicals and distinguish between light and heavy liquids by vapor pressure. These commenters suggest that EPA adopt the established CAA definition based on vapor pressure because including nonvolatiles will (1) result in unnecessary monitoring, and (2) conflict with other statutes such as the CAA, the CWA, Superfund, etc., where these nonvolatiles are not considered hazardous (AESP-L0011, AESP-00010, AESP-L0005, AESP-L0006, AESP-00011, AESP-00003, AESP-L0008, AESP-00018, AESP-00013, AESP-00030, AESP-L0003, AESP-L0001, AESP-00016, AESP-00019, AESP-00033, AESP-L0002, AESP-L0007, AESP-L0011, AESP-L0015, AESP-L0018, AESP-00035, AESP-00002, AESP-00034, AESP-L0009, AESP-00017, and AESP-00024).

Response: To clarify that the equipment leak standards apply to total organic emissions from hazardous wastes, the term "in VHAP service" has been dropped from the promulgated rule. However, the EPA agrees that the equipment leak standards should take component volatility into consideration. Previous EPA and industry studies have shown that the volatility of stream components, as a process variable, does correlate with fugitive emission rates (Docket No. F-90-AESF-FFFFF, items S0001 through S0008). An analysis of the vapor pressures and emission rates has shown that substances with vapor pressures of 0.3 kPa or higher had significant emission rates, while those with lower vapor pressures did not. For example, EPA analyses indicate that emissions from valves in light-liquid service are more than 30 times higher than valves in heavy-liquid service (see Section 4.6 of this BID). This result led to the separation of equipment component emissions by service: gas/vapor, light liquid, and heavy liquid. These classifications have been used in most fugitive emission standards to effectively direct the major effort toward equipment most likely to leak. Therefore, the proposed rules for equipment leaks have been revised to account for volatility. For example, pumps and valves in heavy-liquid service must be monitored only if evidence of a potential leak is found. Light- and heavy- liquid service is based on the vapor pressure of the components in the stream (less than 0.3 kPa at 20 °C).

3.2.7 Transfer of the Benzene NESHAP Technology

Comment: Eight commenters (AESP-00035, AESP-00024, AESP-00002, AESP-00005, AESP-00028, AESP-L0015, AESP-L0016, and AESP-00018) object to the regulatory approach of incorporating the benzene NESHAP as the basis of the standards because: (1) this regulation is not applicable to the broad spectrum of wastes found at TSDF, and (2) TSDF differ from the chemical plant and petroleum refineries upon which the benzene standard is based. Most commercial recyclers comment that they do not believe that the benzene NESHAP is appropriate as the basis for emission standards at their facilities because benzene use has been almost entirely phased out except as a raw material in manufacturing and as a gasoline additive. Commenter AESP-L0016 also objects because EPA has not assessed how the cost effectiveness of benzene controls differs when applied to TSDF. Commenter AESP-00018 agrees that the benzene study that is the basis of the original data used to support the proposed standards is inapplicable because of benzene's high volatility, which they say is atypical of TSDF.

Response: The data used by EPA in establishing the benzene fugitive standards are based on emission and process data collected at a variety of petroleum refinery and SOCMI operating units. Data were obtained for equipment and chemical component mixtures that include many of the same organic compounds treated in TSDF hazardous waste management units, not only benzene.

The EPA's Industrial Environmental Research Laboratory (IERL) coordinated a study to develop information on fugitive emissions in the SOCMI (Docket No. F-90-AESF-FFFFF, item S0010). A total of 24 chemical process units were tested; these data covered thousands of screened sources (pumps, valves, flanges, etc.) and included process units handling such chemicals as acetone/phenol, MEK, ethylene dichloride, 1,1,1- trichloroethane, trichloroethylene, and perchloroethylene. Refinery studies on fugitives also include tests on units handling both toluene and xylene (Docket No. F-90-AESF-FFFFF, items S0001 through S0005). These same chemicals are included in those listed by the National Association of Solvent Recyclers (NASR) as solvents commonly recycled by member facilities. (Docket No. F-86-AESP-FFFFF, item L0014).

One of the primary purposes of SOCMI plants is to manufacture organic solvents of the variety found at TSDF. Some refineries also produce organic chemicals and solvents. Because hazardous waste management units such as distillation operations have the same sources of fugitive organic emissions (such as pumps and valves) involved in handling SOCMI chemicals, it is reasonable to expect similar control technology performance and efficiency at hazardous waste management units. The EPA has no reason to believe that the equipment standards would not be applicable to TSDF. Moreover, although EPA has not conducted actual equipment leak testing at TSDF, observations of equipment during plant visits have confirmed that the assumptions and analyses used in other equipment leak standards apply to TSDF as well.

With regard to the concerns of Commenter AESP-L0016 that the cost effectiveness of benzene controls applied to TSDF be assessed, as noted in the response to comment 3.2.3, RCRA excludes selection of controls or standards based on consideration of costs. However, costs were developed to evaluate the economic impacts of the equipment leak standard after control levels were selected. Estimates of the costs for fugitive emission control at WSTF/TSDF model units are presented in Appendix C.

The commenters also express concern about differences in volatilities between SOCMI streams and TSDF waste streams. To avoid unnecessary emission monitoring of equipment handling low volatility streams, the final rules have incorporated the light/heavy liquid designation found in the SOCMI NSPS for equipment leaks.

3.2.8 Accelerated Approach

Comment: Five commenters (AESP-L0018, AESP-00002, AESP-00030, AESP-00035, and AESP-L0025) do not support EPA's regulatory approach of promulgating the proposed standards on an accelerated basis, separate from the comprehensive TSDF standards currently under development. Commenter AESP-L0018 specifically recommends that EPA proceed only with the LDAR provisions and re-propose other requirements when sufficient data and supporting analyses can be provided. Commenter AESP-00002 suggests that EPA delay promulgation until sufficient data are available. Commenter AESP-00025 points out that proceeding with these standards as a separate project would require industry to apply controls that may be obsolete or not cost-effective when considered in conjunction with the comprehensive rules. Commenter AESP-00016 believes EPA should withdraw the entire proposal because it is not adequately supported by the analyses.

Response: The EPA accelerated this portion of the air rules in part to prevent uncontrolled air emissions from LDR treatment technologies. This was possible because control techniques used in meeting current CAA standards for the same types of emission points can easily be applied to TSDF. After proposal, EPA contacted commenters and collected additional, TSDF-specific information for use in vent analyses to respond to the comments received. The EPA has collected and analyzed site-specific data, reviewed control techniques, and revised estimates of emissions, risks, costs, and economic impacts. The results of these analyses are discussed in Chapters 5.0 through 9.0 of this document. The revised impacts analysis conducted by EPA includes a facility-specific analysis for both WSTF (448 facilities) process and fugitive (equipment leak) emissions, and for TSDF (more than 1,400 facilities) fugitive emissions from those waste management processes that handle hazardous waste streams with at least 10 percent organics. While a wealth of data is not available on all aspects of these standards, EPA has no reason to believe that the standards should be delayed. In fact, the impacts of delay are compelling reasons to move ahead, given the available control techniques and existing standards that form the basis for these rules.

As discussed in other responses to comments in this document, the Phase II Section 3004(n) rules currently under development affect other air sources at TSDF that require different types of data and technical approaches. These standards are scheduled for proposal in mid-1990. The EPA does not believe that the implementation of standards that require add--on controls for process vents and a combination of an LDAR program, work practices, and controls for equipment leaks will impair or be rendered obsolete by design and engineering plans for other sources.

4.0 APPLICABILITY AND EXEMPTIONS

4.1 APPLICABILITY OF STANDARDS FOR STORAGE TANKS AND ACCUMULATOR VESSELS

Comment: Commenters AESP-L0001 and AESP-00024 object to the regulatory approach of applying a single standard to the wide varieties of accumulator vessels (AV) irrespective of the chemical constituents that are present and the size of the vessel because the proposed standards result in the control of already low emission rates at disproportionately high costs. The commenters state that the standards for tanks (whether accumulation or storage tanks) should be conditioned by the size of the vessel, the vapor pressure of the material being stored, and the type of units that pose a risk to human health and the environment. Commenter AESP-00022 recommends that EPA establish a minimum tank size that will not be regulated and urges that a minimum vapor pressure be used to determine which tank contents will be classified as VO or as semivolatile (unregulated) organics because accurate estimates of total VO cannot be made for tank contents unless a specific cutoff is established. Commenters AESP-L0002 and AESP-00033 also support the development of tank standards that consider size and vapor pressure and suggest that EPA's approach should be similar to or consistent with the CAA NSPS for petroleum liquid storage vessels (40 CFR 60, Subpart Ka). These standards exempt vessels that store liquids less than 1.5 psia or that store less than 40,000 gal.

Response: Commenters recommending that the air emission standards be conditioned by the size of the tank and the vapor pressure of the material being stored have misinterpreted the applicability of the proposed standards. To clarify the applicability of the standards, the term "product accumulator vessel" has been dropped from the promulgated rule, including the equipment definition, and the process vent definition has been revised to be specific to the applicable emission sources. "Process vent" is defined to mean "any open-ended pipe or stack that is vented to the atmosphere either directly, through a vacuum-producing system, or through a tank (e.g., distillate receiver, condenser, bottoms receiver, surge control tank, separator tank, or hot well) associated with distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operations." Similarly, the definition of "vented" has been revised to specifically exclude the passage of liquids, gases, or fumes "caused by tank loading and unloading (working losses)." Because tank working and breathing losses are not considered process emissions, the comments concerning vapor pressure and tank size exemptions are not relevant. It should be noted, however, that EPA is considering the regulation of hazardous waste storage tanks, along with various other TSDF air emission sources, in the Phase II, Section 3004(n) TSDF air standards now being developed and evaluated by the Agency. In the development of these standards, EPA will consider such factors as size of the tank and the volatility of the material being stored.

In conducting the impact analysis of the TSDF process vent standards, EPA considered and took into account the relative size of TSDF process units and the wide range of chemicals processed in the TSDF industry. For example, three sizes of model units (each with a range of operating parameters) were defined for analysis of emissions, health risks, and economic impacts in the final rulemaking. The final standards for process vents promulgated by EPA are effectively conditioned by the size of the unit (i.e., process throughput) by requiring controls at facilities whose total process vent emissions are greater than 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr). Emission estimates were based on facility throughputs; therefore, adequate consideration has been given to the TSDF facility and process unit size in establishing the standards. A more detailed discussion of the process vent cutoff is provided in response to comment 7.1.

4.2 SELECTION OF THE 10-PERCENT CUTOFF

Comment: Commenters AESP-00014 and AESP-L0015 ask EPA to evaluate the health and environmental impacts associated with the proposed 10-percent cutoff; Commenter AESP-00008 recommends that a reduction in the limit or a different parameter be used because, at the current level, the standards would not apply to very many facilities. As discussed in comment 3.2.6, numerous commenters state that the volatility of the wastes should be considered. Commenter AESP-L0016 states that the 10-percent limit will allow excessive emissions from leaking equipment and is based on costs, not technical feasibility. The commenter argues that the 10-percent limit does not adequately protect the environment because emissions could be substantial if there are numerous leaking components with relatively dilute streams because controls, such as carbon adsorbers, are available to capture emissions from dilute streams. The commenter cites Raoult's law to show how, at higher temperatures, affected solvents could vent more than 10,000 ppm (1 percent) even if their concentration were less than 10 percent and generate significant emissions that remain uncontrolled. According to Commenter AESP-L0016, affected vessels, like distillation columns, contain materials with differing concentrations throughout their length. If the 10-percent limit relates to the input stream to such a column, then parts of the same piece of equipment would contact wastes at lower concentrations. For these reasons, Commenter AESP-L0016 states that EPA should abandon the cutoff approach based on concentration and focus on the emissions that escape capture.

Response: As proposed, the 10-percent total organics cutoff level for applicability of the standards covered both equipment leak (fugitive) emissions and process vent emissions. Control technologies for fugitive emissions comprise the use of control equipment, inspection of equipment, and repair programs to limit or reduce emissions from leaking equipment. These control technologies have been studied and evaluated for equipment containing fluids with at least 10 percent organics (EPA-450/3-80-032b, EPA-450/3-80-033b, EPA-450/3-82-010, and EPA-450/3-86-002.) The 10-percent criterion was chosen in EPA's original benzene/SOCMI studies to focus the analyses on air emissions from equipment containing relatively concentrated organics and presumably having the greatest potential for air emissions. Available data from the original benzene/SOCMI studies do not suggest that fugitive emissions from leaking equipment (e.g., pumps and valves) handling streams containing less than 10 percent organics are significant or that the 10-percent cutoff allows excessive emissions from dilute streams. However, to re-evaluate this would require several years to conduct field studies to collect and analyze additional emissions and control effectiveness data for equipment leaks. Because available data support the need for and effectiveness of standards for equipment handling streams containing at least 10 percent organics, the EPA does not believe that a delay in rulemaking to assess emissions and controls for equipment handling streams containing less than 10 percent organics is warranted.

The effectiveness of fugitive emission control technologies has been thoroughly evaluated for equipment containing fluids with at least 10 percent organics, and fugitive emission standards have been proposed or established under both Sections 111 and 112 of the CAA. (See 46 FR 1136, January 5, 1981; 46 FR 1165, January 5, 1981; 48 FR 279, January 4, 1983; 48 FR 37598, August 18, 1983; 48 FR 48328, October 18, 1983; 49 FR 22598, May 30, 1984; 49 FR 23498, June 6, 1984; and 49 FR 23522, June 6, 1984.) As elaborated in these rulemakings, a 10-percent cutoff deals with the air emissions from equipment most likely to cause significant human health and environmental harm.

With regard to process vent emissions, EPA agrees with the commenter. Emission test data show that the 10-percent cutoff potentially may allow significant emissions from process vents on a mass-per-unit-time basis (e.g., kilograms per hour or megagrams per year). As public commenters pointed out, the 10-percent cutoff for process vents does not limit total emissions, nor does it relate to emissions that escape capture by existing control devices. Therefore, the 10-percent cutoff may not be appropriate; as a result, EPA has eliminated the 10-percent cutoff as it applies to process vents. The EPA believes that an emission rate limit more effectively relates to emissions, emission potential, and health risks than does a 10-percent organic concentration cutoff. Accordingly, a health-risk-based facility process vent emission rate limit has been added to the final rules in lieu of the 10-percent cutoff.

Because the emission rate limits (3 lb/h and 3.1 ton/yr) provide reasonable health-based cutoffs, EPA considered dropping completely the organic content criterion (i.e., at least 10 percent total organics). However, EPA decided not to completely eliminate the organic content criterion because it is not clear that the same controls can be applied to very-low-concentration streams as can be applied to the higher-concentration streams that generally are associated with emission rates greater than the limits. For low-concentration streams, EPA questions whether controls are needed on a national or generic basis, but is unable to resolve this question at this time. Thus, EPA decided to defer controlling very-low-concentration streams until it is able to better characterize and assess these streams and the appropriate controls.

Once EPA decided to consider facilities that manage very-low-concentration organic wastes as a separate category, there remained the problem of determining the appropriate criterion. The EPA examined existing data on air strippers, the treatment device most commonly used with low-concentration streams; and it appeared that the quantity of emissions and the risk associated with air strippers treating streams with concentrations below 10 ppmw may be relatively small, thus minimizing the potential harm of deferring control until a later time. Table 4-1 presents a summary of the data available on air stripping operations treating either ground water or wastewater. Examples of facilities managing low-concentration wastes are sites where ground water is undergoing remedial action under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or corrective action pursuant to RCRA. Based on the limited set of precise data available, and the comments that the 10-percent criterion was too high, EPA determined that an appropriate criterion would be 10 parts per million (ppm) total organics in the waste on a time-weighted, annual average basis.

The 10 ppmw is not an exemption from regulation; it is intended only as a way for EPA to divide the air regulations into phases. The EPA is deferring action on very-low-concentration streams (i.e., ones with less than 10 ppmw total organic content) from the final rule today but will evaluate and announce a decision later on whether to regulate these waste streams.

4.3 EXEMPTIONS FOR SMALL SOLVENT RECOVERY OPERATIONS

Comment: Commenters AESP-00020, AESP-00017, AESP-L0004, and AESP-L0011 ask EPA to consider exemptions for small solvent recovery operations. Specific recommendations from commenters included exempting: (1) batch processes of 55 gal or less, including drums or tanks holding solvent and drum storage facilities (AESP-L0004); (2) systems where waste is

TABLE 4.1 AIR STRIPPER DATA SUMMARY[1-4]

Air[a] stripper	Current controls	Organic[b] emissions, lb/h	Maximum influent organic concentration, ppmw	Average influent organic concentration, ppmw	Influent flow rate, gal/min
1	Y	5.1	2,278	113.9	300
2	Y	0.5	359	17.95	53
3	N	0.17	1,317	65.85	50
4	N	1.17	3.37	0.1685	400
5	N	0.5	ND	ND	259
6	Y	0.15	3.964	0.1982	100
7	Y	0.42	0.59	0.0295	400
8	N	2.31	0.72	0.036	2,847
9	N	0.05	6.77	0.3385	90
10	N	1.85	0.39	0.0195	3,704
11	N	0.72	10.67	0.5335	1,400
12	Y	0.3	4.37	0.2185	600
13	N	0.01	3,688	184.4	80
14	N	0.4	0.03	0.0015	6,250
15	N	0.01	0.04	0.002	500
16	Y	0.0003	0.19	0.0095	40
17	Y	0.14	ND	ND	ND
18	N	0.0066	3.3	0.165	ND
19	Y	ND	61.86	3.093	ND
20	?	ND	29.5	1.475	ND
21	Y	ND	0.186	0.0093	ND
22	N	ND	0.19	0.0095	ND
23	N	ND	0.22	0.011	ND
24	Y	ND	9.62	0.481	ND
25	Y	ND	35.62	1.781	ND
26	N	ND	0.34	0.017	ND
27	?	ND	0.24	0.012	ND
28	Y	ND	1.56	0.078	ND
29	Y	ND	1.05	0.0525	ND
30	N	ND	10.18	0.509	ND
31	N	ND	4.79	0.2395	ND
32	N	ND	323.8	16.19	ND
33	Y	ND	138.85	6.9425	ND
34	Y	ND	4,017	200.85	ND
35	Y	ND	0.88	0.044	ND
36	?	ND	0.04	0.002	ND
37	N	ND	0.87	0.0435	ND
38	Y	ND	1.344	0.0672	ND
39	Y	30	13,495	8,100	31
40	Y	320	999	750	637
41	N	0.8	746.5	440	2

(continued)

TABLE 4.1 AIR STRIPPER DATA SUMMARY[1-4]

Air[a] stripper	Current controls	Organic[b] emissions, lb/h	Maximum influent organic concentration, ppmw	Average influent organic concentration, ppmw	Influent flow rate, gal/min
42	Y	0.01	99	55	18
43	N	36	30.7	18.6	2,353
44	Y	8.5	19.8	12	865
45	Y	0.39	9.9	6	79

ND = No data available.

[a] Air strippers numbered 1 through 38 are located at CERCLA remedial action sites; those numbered 39 through 45 are located at RCRA hazardous waste TSDF sites.

[b] For those units that currently have controls, the emission value represents the emissions with the controls in place.

[c] In some cases, average concentrations were estimated using a correlation between maximum and average concentrations for the available data.

accumulated but pumped for a few hours each month; and (3) small (e.g., 5 gal) sumps containing 2 to 4 gal of solvent each (AESP-00017).

Response: As proposed, all WSTF/TSDF would have to install control devices on all condenser and other process vents regardless of emission levels. Through reanalysis of the WSTF/TSDF air quality and health impacts using updated model unit, emission rate, and facility throughput data, EPA has determined that a minimum allowable process vent emission rate applicable to all facilities is appropriate. The health impact analysis conducted to assess the magnitude of cancer risk from exposure to air emissions from WSTF process vent emissions shows for both MIR and nationwide annual cancer incidence that there is an emission level from process vents that is protective of human health and the environment, and below which additional emission control results in no appreciable reduction in health risks.

The risk analysis results indicate that provision of a "small-facility" cutoff of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) to total facility process vent emissions provides essentially the same level of protection for public health as does the proposed standard with coverage including all WSTF/TSDF nationwide. This cutoff effectively eliminates concerns over controlling very small sources. Control of facilities with process vent emissions less than the emission rate limit would not result in further reductions of either cancer risk or annual incidence on a nationwide basis. Facilities with organic emissions from process vents that do not exceed these emission rates will not have to install controls. A detailed discussion of the determination of the small-facility cutoff is presented in the response to comment 7.1.

4.4 TOTALLY ENCLOSED TREATMENT FACILITY EXEMPTION

Comment: Commenter AESP-00026 disagrees with EPA's interpretation that the definition of "totally enclosed treatment units" (which are exempt from regulation) may in certain circumstances include onsite treatment units that use engineered controls to prevent the release of emissions. The commenter states that onsite treatment facilities associated with process equipment have the same potential for emissions as other sources not exempted by the proposed regulation. Commenter AESP-L0015, however, agrees with EPA's proposed interpretation.

Response: The EPA notes that this rule does not create or modify any exemption for totally enclosed treatment facilities; rather, the existing definition of and exemption for totally enclosed treatment facilities (40 CFR 264.1(g)(5) and 40 CFR 265.1(c)(9)) remain in effect, and existing regulatory interpretations remain in effect as well. As presented in the preamble to the proposed rule, under 40 CFR 264.1(g)(5) and 40 CFR 265.1(c)(9), totally enclosed treatment facilities are exempt from RCRA regulation. A "totally enclosed treatment facility" is a facility treating hazardous waste that is "directly connected to an industrial production process and which is constructed and operated in a manner which prevents the release of any hazardous waste or constituent thereof into the environment during treatment" (40 CFR 260.10). Treatment facilities located off the site of generation are not directly connected to an industrial process. Thus, commercial waste treatment facilities with equipment affected by the final standards, such as solvent reclamation facilities, by definition ordinarily would not be totally enclosed. In addition, storage facilities, disposal facilities, and ancillary equipment not used for treating hazardous waste do not fall within the definition of a totally enclosed treatment facility.

The EPA believes that many onsite treatment facilities also are not totally enclosed. Process emissions from distillation columns and other treatment technologies generally are designed to release air emissions of the hazardous waste or constituent into the air environment. Therefore, by definition, these on-site technologies are generally not totally enclosed. (See 45 FR 33218, May 19, 1980 [no constituents released to air during treatment].)

There are two important characteristics that define a totally enclosed treatment facility. The key characteristic of a totally enclosed treatment facility is that it does not release any hazardous waste or constituent of hazardous waste into the environment during treatment. Thus, if a facility leaks, spills, or discharges waste or waste constituents, or emits wastes or waste constituents into the air during treatment, it is not a totally enclosed treatment facility within the meaning of these regulations.

The EPA agrees with Commenter AESP-00026 that onsite treatment facilities associated with process equipment generally are designed to release air emissions and thus are not "totally enclosed." The EPA specifically stated this in the preamble to the proposed rule. To be considered "totally enclosed," units must meet the test of preventing the release of any hazardous constituent from the unit not only on a routine basis but also during a process upset. Thus, the risks from these units are expected to be less than from units that are not totally enclosed.

This rule does not create or modify any exemption for totally enclosed treatment facilities; rather, the existing definition of an exemption for totally enclosed treatment facilities remains in effect, and existing regulatory interpretations remain in effect as well. Although the preamble to the proposed rule repeated the existing definition, it also contained a request for comments on an interpretation of the totally enclosed facility exemption whereby the "use of effective controls such as those required by the proposed standard" would meet the criteria of 40 CFR 260.10. Upon consideration of the comments, the Agency has determined that this interpretation would have conflicted with the regulatory definition and previous interpretations of the exemption and therefore has decided to withdraw it.

4.5 EXEMPTION FOR 90-DAY STORAGE

Comment: Commenter AESP-L0018 objects to the exemption for AV storing or treating hazardous wastes that are emptied every 90 days and meet the tank standards of 40 CFR 262.34, provided a permit is not needed. According to the commenter, this exclusion is justified based on cost or technological grounds, but not on risk as RCRA requires. The commenter states that this exclusion will increase the use of the 90-day storage exemption and the resultant air emissions.

Response: In 40 CFR 270, hazardous waste generators who accumulate waste onsite in containers or tanks for less than the time periods provided in Section 262.34 are specifically excluded from RCRA permitting requirements. In order to qualify for the exclusions in Section 262.34, generators who accumulate hazardous waste onsite for up to 90 days must comply with 40 CFR 265 Subpart I or J (depending on whether the waste is accumulated in containers or tanks) and with other requirements specified in Section 262.34. Small quantity generators (i.e., generators who generate more than 100 kg but less than 1,000 kg per calendar month) are allowed to accumulate waste on-site for up to 180 days or, if they must ship waste off-site for a distance of 200 mi or more, and if they meet certain other requirements set out in Section 262.34, for up to 270 days.

The promulgated regulation does not create a new exemption for 90-day accumulation; nor does it modify the existing regulation. As the commenter notes, EPA is considering what changes (if any) should be made to Section 262.34 (the "90-day rule") under a separate rulemaking (51 FR 25487, July 14, 1986). As part of that effort, the Agency currently is evaluating whether air emissions from these and other accumulator tanks at the generator site should be subject to additional control requirements. Preliminary analysis indicates that 90-day tanks and containers may have significant organic air emissions; consequently, as part of the second phase of TSDF air emission regulations, the Agency intends to propose to modify the exemption to require that 90-day tanks meet the control requirements of the Phase I and II standards. (The multiphased standards development approach for regulating organic air emissions is discussed in response to comment 11.5.2.) Until a final decision is made on regulating the emissions from these units, they will not be subject to additional controls. However, EPA does not believe that more generators will use the 90-day exemption if air emission controls are not imposed. Those generators who are eligible for inclusion under Section 262.34 are probably already taking advantage of the provision now by storing their hazardous wastes for less than 90 days.

4.6 LEAK DETECTION AND REPAIR (LDAR) PROGRAM

4.6.1 Exemption for Light/Heavy Liquids

Comment: Several commenters criticize the incorporation of the benzene NESHAP because of differences in scope from the SOCMI NSPS in that: (1) the NSPS distinguishes between light and heavy liquids and the proposed standards based on the benzene NESHAP do not; (2) the NSPS does not require testing of all SOCMI units because process fluid vapor pressure is the overriding consideration in predicting leak frequencies and leak rates (the proposed standards incorporating the NESHAP do not recognize vapor pressure and require testing of all SOCMI units); and (3) the NSPS exempts facilities from routine fugitive emission monitoring, inspection, and repair provisions if a heavy-liquid product from a heavy-liquid raw material is produced and limits monitoring of equipment in heavy-liquid service only to where there is evidence of a potential leak.

Response: The EPA agrees with the commenters that the provisions for light and heavy liquids in the SOCMI NSPS should be incorporated in the Section 3004(n) standards, even though the Subpart V NESHAP does not contain the distinction. No distinction was made for the benzene NESHAP because benzene is a light liquid. By their nature, heavy liquids exhibit much lower volatilities than do light liquids, and because equipment leak rates and emissions have been shown to vary with stream volatility, emissions for heavy liquids are less than those for lighter, more volatile ones. For example, EPA analyses have determined that the emission rate for a valve in heavy-liquid service is more than 30 times less than the emission rate for a valve in light-liquid service. Therefore, a routine LDAR monthly inspection is not necessary for equipment in heavy-liquid service.

Thus, the final regulations have been changed to incorporate the light-liquid service provisions for pumps and valves. Equipment is in light-liquid service if the vapor pressure of one or more of the components is greater than 0.3 kPa at 20 °C, if the total concentration of the pure components having a vapor pressure greater than 0.3 KPa at 20 °C is equal to or greater than 20 percent by weight, and if the fluid is a liquid at operating conditions. The 0.3 kPa vapor pressure criterion is based on fugitive emission data gathered in various EPA and industry studies. Equipment processing organic liquids with vapor pressures above 0.3 kPa leaked at significantly higher rates and frequencies than did equipment processing streams with vapor pressures below 0.3 kPa. Therefore, EPA elected to exempt valves processing lower vapor pressure substances (i.e., heavy liquids) from the routine LDAR requirements of the standards. That is, facilities are exempted from routine fugitive emission monitoring, inspection, and repair provisions for equipment if a heavy liquid is processed. In addition, instrument monitoring of equipment in heavy-liquid service is required only where there is evidence by visual, audible, olfactory or any other detection method of a potential leak.

4.6.2 Exemption for Small Facilities

Comment: Several commenters ask EPA to consider exemptions from fugitive emission monitoring for small facilities based on volume, as was done in the benzene NESHAP and the SOCMI NSPS (AESP-00018, AESP-00034, and AESP-00002), based on an emission threshold (AESP-L0011), based on a product applicability threshold or equipment component count (AESP-L0001 and AESP-L0025), or based on equipment size, such as for small tanks and pumps (AESP-00026). In support, the commenters point to similar exemptions in the CAA rules, but not in the proposed standards, and state that costs are higher for control of their very small operations compared to the emission reduction that would be achieved.

Response: The commenters suggest that EPA consider other exemptions for fugitive emission monitoring that are applied in the benzene NESHAP or SOCMI NSPS (e.g., small facilities with the design capacity to produce less than 1,000 Mg/yr). The EPA also recognizes that estimated emissions and health risks from small facilities should be considered in the final rules. With regard to the SOCMI NSPS small facility exemption, the cutoff was based on a cost-effectiveness analysis. Under Section 112 of the CAA, EPA may exempt units for which costs of the standards are unreasonably high in comparison to the emission reduction achievable.

Under RCRA, the statutory criterion is to protect human health and the environment. Therefore, any cutoff for RCRA standards must be risk-based. Cost effectiveness is only a relevant factor under RCRA in selecting among equally effective control technologies (45 FR 33089, May 19, 1980).

In addition, data from fugitive emissions tests do not show any definite relationship between emissions and process throughput above some minimal quantities. Fugitive emissions are more closely related to the equipment count in a facility than to the facility size or process throughput. Furthermore, each type of equipment has a different equipment leak fugitive emission rate. Fugitive emissions are also a function of the chemical characteristics of the hazardous wastes being handled.

Typically, TSDF have a variety of hazardous waste management processes (e.g., container storage, tank storage, treatment tanks, incinerators, injection wells, and terminal loading operations) located at the same facility, all of which have associated pumps, valves, sampling connections, etc., and therefore, fugitive emissions from equipment leaks. Also, several different types of hazardous waste typically are managed at a facility. Because of the various factors affecting facility fugitive emissions from equipment leaks (e.g., equipment leak emissions are a function of equipment component counts rather than throughput of the unit), it would be very difficult to determine a small facility exemption based on risk and expressed as volume throughput. For these reasons, EPA did not include exemptions for fugitive emission monitoring such as those applied in the benzene NESHAP or SOCMI NSPS (i.e., small process units with the design capacity to produce [process] less than 1,000 Mg/yr).

4.6.3 Exemption for Vacuum Systems

Comment: Commenter AESP-L0002 notes that the benzene NESHAP allows exemptions for vacuum systems, systems with no emissions, and systems for which the leakage rate is demonstrated to be below 2 percent.

Response: The EPA has included in the final TSDF standards (Sections 264.1050(e) and 265.1050(e)) the exemption for equipment "in vacuum service" found in the benzene NESHAP (40 CFR Subpart V, 61.242-1). Also included are the identification requirements contained in the regulation. "In vacuum service" means that equipment is operating at an internal pressure that is at least 5 kPa below ambient pressure. The EPA has concluded that it is unnecessary to cover equipment (e.g., pumps, valves, compressors, and closed vent systems) "in vacuum service" because such equipment have little if any potential for emissions and therefore, do not pose a threat to human health and the environment. Therefore these equipment have been excluded from the equipment leak fugitive emission requirements.

The proposed standards stated that owners and operators of facilities subject to the provisions of the proposed rule shall comply with the requirements of 40 CFR Part 61, Subpart V, except as provided in the rule itself. The provisions of the proposed rule did not exclude Section 61.243, alternative standards for valves in VHAP service, and the alternative standards have been incorporated as Sections 264.1061, 264.1062, 265.1061, and 265.1062 of the final rule. Therefore, an owner or operator may elect to have all valves within a TSDF hazardous waste management unit comply with an alternative standard that allows no greater than 2 percent of the valves to leak (Sections 264.1061 and 265.1061) or may elect for all valves within a hazardous waste management unit to comply with one of the alternative work practices specified in paragraphs (b)(2) and (3) of Sections 264.1062 and 265.1062.

4.6.4 Flanges and Pressure Relief Devices

Comment: Commenter AESP-L0016 recommends that any release from pressure relief devices in gas service be directed to control equipment at least equal in performance to those for other process sources or an alternative means provided to prevent an uncontrolled discharge. According to the commenter, rupture discs or closed-vent systems restrict small leaks but not major releases; a closed-vent system connected to a control device is needed to capture releases. The commenter also states that pipeline flanges can be controlled by tightening bolts. The commenter concluded that EPA has provided no data to support exempting flanges and pressure relief devices in liquid service from LDAR requirements. The EPA should not rely on operators to see, hear, or smell leaks from these equipment.

Response: Pressure relief devices allow the release of vapors or liquids until system pressure is reduced to the normal operating level. The standards are geared toward control of routine low-level equipment leaks that may occur independent of emergency discharges. Pressure relief discharges are an entirely different emission source than are equipment leaks or process vents and were not covered in the original equipment leak standards under the CAA. The new Subpart BB rules require that pressure relief devices in gas service be tested annually by Method 21 (and within 5 calendar days of any relief discharge) to ensure that the device is maintained at no detectable emissions (i.e., less than 500 ppm above background, as measured by EPA Reference Method 21) by means of a rupture disc. The EPA does not believe that additional measures are warranted. In addition, because a pressure discharge constitutes a process upset that in many cases can lead to hazardous waste management unit downtime and might also pose a risk to workers, a facility has the incentive to minimize the occurrence of these events.

The frequency, duration, and air emissions associated with such emergency discharges at TSDF waste management units cannot currently be estimated with any certainty on a nationwide basis. However, if a pressure discharge does occur, records and reports maintained at the site (under Sections 264.1054, 264.1064, 265.1054, and 265.1064 of Subpart BB) will indicate the frequency of such discharges, the estimated volume of excess emissions, and other relevant information. If pressure discharges appear to be a problem at any facility, the RCRA permitting system provides State or EPA permit writers the flexibility to require closed-vent systems for these discharges on a site-specific basis.

The LDAR program transferred from the CAA standards does not exempt pressure relief devices and flanges in heavy-liquid service, but requires formal monitoring of these sources if operators see, smell, or hear discharges. The EPA considers that this is the most practical way to manage these sources. Although scheduled routine maintenance (e.g., tightening bolts on pipeline flanges) may be a way of avoiding the need for formal monitoring, it may not be a successful method for all sites in eliminating leaks due to the numerous variables affecting leak occurrence. For example, flanges may become fugitive emission sources when leakage occurs due to improperly chosen gaskets, poorly assembled flanges, or thermal stress resulting in the deformation of the seal between the flange faces. In these situations, operators will be able to detect such leaks by sight, smell, or sound. Support for this approach was presented and evaluated in developing background and support for several CAA rulemakings (EPA-450/3-83-016b, EPA-450/3-80-033b, and EPA-450/3-81-015b).

4.6.5 Directed Maintenance, Leak Definition, and Petition for Reconsideration of the Benzene Standards

Comment: Commenter AESP-L0016 includes in their comments their petition for reconsideration of the benzene fugitive standards. Although the comments are directed at the CAA standards, they contain numerous suggestions for modifications to the LDAR program that have previously been raised with EPA. Also included in their comments, however, are recommendations regarding directed maintenance and the 10,000-ppm leak definition that are specific to the proposed standards. On the question of directed maintenance, the commenter believes that the LDAR program should require preventive maintenance, such as the periodic replacement of valve packings before waiting for the valve to fail. In support, the commenter argues that EPA's own data show that directed maintenance could reduce leaks from valves to below 10,000 ppm. The commenter also criticizes the 10,000-ppm leak definition as being too high and states that EPA must consider the level in terms of the health effects.

Response: The key criterion for selecting a leak definition is the overall mass emission reduction demonstrated to be achievable. The EPA has not concluded that an effective lower leak definition has been demonstrated. Most data (EPA-450/3-82-010) on leak repair effectiveness have applied 10,000 ppm as the leak definition and therefore do not indicate the effectiveness of repair for leak definitions between 1,000 and 10,000 ppm. Even though limited data between these values were collected for support of CAA standards, they are not sufficient to support a leak definition below 10,000 ppm. A net increase in mass emissions might result if higher concentration levels result from attempts to repair a valve with a screening value between 1,000 and 10,000 ppmv. Data are insufficient to determine precisely at what screening value maintenance efforts begin to result in increased emissions.

As the commenter noted, although there is some evidence that directed maintenance* is more effective, available data are insufficient to serve as a basis for requiring directed maintenance for all sources.

The EPA believes that there is only a small potential emission reduction for leaks having total organic concentrations between 1,000 and 10,000 ppmv. Therefore, using a lower leak definition would not increase emission reductions significantly, even if EPA judged that repair was effective for leaks of 1,000 ppmv. In the proposal BID for the petroleum refinery fugitive emission NSPS (Docket Item II-A-43, p. 4-8), there is a comparison of the percentage of total mass emissions affected by selecting a 10,000-ppmv leak definition over a 1,000-ppmv leak definition. These percentages represent maximum theoretical emission reductions that could be expected if the sources were instantaneously repaired to a zero leak rate and no new leaks occurred. For valves in gas service, the estimated decrease is only 1 percent. This small potential decrease in emissions may be more than offset by counterproductive attempts to repair sources with low leaks.

---

*In "directed maintenance" efforts, the tightening of the packing is monitored simultaneously and is continued only to the extent that it reduces emissions. In contrast, "undirected" repair means repairs such as tightening valve packings without simultaneously monitoring the result to determine if the repair is increasing or decreasing emissions.

The EPA's rationale for selecting the 10,000-ppmv leak definition and for not requiring directed maintenance under the CAA LDAR program also has been discussed in the proposal and promulgation BIDs for benzene emissions from coke by-product recovery plants (EPA-450/3-83-016 a and b), for SOCMI fugitive emissions (EPA-450/3-80-033 a and b), for petroleum refinery fugitive emissions (EPA-450/3-81-015 a and b), and for benzene fugitive emissions (EPA-450/3-80-032 a and b). (See also the "Response to Public Comments on EPA's Listing of Benzene Under Section 112" [EPA-450/5-82-003] "Fugitive Emission Sources of Organic Compounds--Additional Information on Emissions, Emission Reductions, and Costs" [EPA-450/3-82-010], and EPA's "Response to Petition for Reconsideration" [50 FR 34144, August 23, 1985].)

In summary, EPA cannot conclude that additional emission reductions could be achieved by reducing the leak definition from 10,000 to 1,000 ppmv. In the absence of data supporting the repair potential associated with leak definitions such as 1,000 ppmv, EPA is selecting the clearly demonstrated leak definition of 10,000 ppmv instead of a lower level.

The commenter also criticizes EPA for not reanalyzing the health effects of the 10,000-ppmv level before applying the limit to TSDF under RCRA. Because the CAA and RCRA are almost identical in their recognition of health risk as the predominant decision factor, the EPA believes that the leak definition has been adequately analyzed under the CAA and that further evaluation is not needed prior to transferring it as part of the LDAR program under RCRA. It must also be pointed out that transfer of the CAA equipment leak standards is only the first phase of EPA's regulatory actions related to control of TSDF air emissions. In this phase, EPA transferred a known technology to reduce emissions. If new data show that a lower leak definition is appropriate, the Agency will then consider whether it is appropriate to change the rules.

4.7 REFERENCES

1. U.S. Environmental Protection Agency. Air Stripping of Contaminated Water Sources Air Emissions and Controls. Air Toxics Control Center. Research Triangle Park, NC. July 20, 1987.

2. U.S. Environmental Protection Agency. Air Strippers and Their Emission Controls at Superfund Sites. Hazardous Waste Engineering Research Laboratory. Cincinnati, OH. EPA/600/D-88/153. August 1988.

3. Memorandum from Vickery, James, EPA/OSWER, to Susan Wyatt, EPA/OAQPS/ESD. May 17, 1989. Ground water concentration data for 41 Superfund sites.

4. Memorandum from Kong, E. J., and Coy, David, RTI, to Accelerated Rule Project File. May 9, 1989. Data and information for air strippers treating hazardous wastes.

5.0 ENVIRONMENTAL IMPACTS

5.1 DATA, ANALYSES, AND METHODOLOGY

Comment: Several commenters criticize the lack of data and information supporting the impact analyses. Numerous commenters criticized the emission estimates because: (1) no actual data from operating facilities were used (AESP-L0001 and AESP-00028); (2) the estimates are not supported by any technical data base, and EPA has used out-of-date assumptions regarding the magnitude of the emissions (AESP-L0001, AESP-00019, and AESP-L0003); and (3) the role of State controls has not been considered (AESP-L0001, AESP-L0017, and AESP-00016). Commenters AESP-00002 and AESP-00035 add that EPA has not shown that air emissions from WSTF present a human health or environmental threat because the analysis is based on extrapolated data on the number of WSTF nationwide, the number of WSTF that are TSDF and are thus affected by the rule, and the number of WSTF that are commercial recycling facilities. Extrapolation also was used to estimate equipment leak emissions from WSTF based on the benzene data; according to the comments, EPA should base the analyses on factual knowledge and not on extrapolated data. Commenters AESP-L0015 and AESP-L0017 state that EPA has not justified applying the same control technology for all of the substances in recycled waste streams.

Response: In response to these comments, EPA reviewed all available WSTF site-specific data, including vent emission measurements from primary and secondary condensers, condensers vented to tanks, and vacuum distillation vents. In addition, emission data were requested in the proposal preamble and through Section 3007 questionnaires mailed to nine small and nine large TSDF after proposal. The responses to these information requests have provided considerable data for inclusion in the post-proposal analysis. For example, one respondent supplied data on emissions from batch stills at four different facilities. The data reviewed for WSTF process vents represented the most prevalent configurations for venting the process emissions subject to this regulation and led to the development of wide ranges of flow rates and emission rates. Based on all this information, EPA has revised both model units and WSTF emission factors for inclusion in the impacts analysis. The revised model unit emission factors developed from the emission test data are discussed in response to comment 5.2.

State regulations also were reviewed to help better establish baseline emissions. In general, PSD permit requirements apply to a new or modified source with the potential to emit more than 40 tons/yr of VOC. For sources where CTG are not available, such as TSDF, VOC standards applicable in the State or a particular attainment or nonattainment area could be applied. (A total of 37 States have ozone nonattainment areas.) However, from the review of these standards, it does not appear that there would be general control requirements for TSDF process vents. No CTG have been developed for WSTF/TSDF sources that would generally have potential VOC emissions of less than 40 tons/yr. Responses to the survey of nine large TSDF also do not indicate control requirements for process vents. Several of the facilities that were requested to provide information reported requirements for obtaining air contaminant source operating permits, but they reported no permit requirements for controlling process vent emissions. Therefore, baseline emissions should be related to the efficiency of existing primary condensers and to the existence and efficiency of vent control devices. These factors are reflected in the revised range of emission estimates based on site-specific emission data.

As is discussed in response to comment 3.2.1, EPA has developed an industry profile using results of the 1986 Screener Survey. The Screener Survey data represent all of the TSDF active in 1985 with interim status or final RCRA permits, which totalled about 3,000 facilities. Review of the Screener Survey data shows that a total of 448 facilities reported some type of solvent recovery operation at the facility. Operations categorized as solvent recovery for the survey were those recovering the organic constituents from waste for the primary purpose of recovering organic compounds for reuse. Solvent recovery includes units that are referred to as batch distillation, fractionation, or steam stripping units. The EPA used these actual facility counts together with their reported 1985 waste solvent throughputs as the basis for the post-proposal impacts analysis.

The constituents selected for analyses of control technologies are considered to be representative of the industry, based on a review of relevant information and literature, including a survey of member companies submitted by the NASR, 23 site-specific plant visit reports, responses to 17 EPA questionnaires from small and large facilities (Docket No. F-90-AESF-FFFFF, items S0017, S0018, S0019, S0020, S0022, S0024 through S0026, S0028 through S0036, and S0038 through S0041), the Industrial Studies Data Base (ISDB) (Docket No. F-90-AESF-FFFFF, item S0027), and a data base created by the Illinois EPA (Docket No. F-90-AESF-FFFFF, item S0045). The NASR survey provided information on the types of solvents most frequently recycled at member facilities; the site-specific information and EPA survey responses included waste composition data. The ISDB is a compilation of data from ongoing, in-depth surveys conducted by EPA's OSW of designated industries that are major hazardous waste generators. The Illinois EPA data base contains information from about 35,000 permit applications. Generators must submit one application for each hazardous and special nonhazardous waste stream managed in the State of Illinois. The ISDB and Illinois EPA data bases are discussed in more detail in Appendix D.

Each of these data bases contains waste stream characterization data for numerous generic spent solvent waste streams (EPA Hazardous Wastes F001-F005) and D001 wastes (ignitable), which information from the Screener Survey indicates are also recycled. The constituents that were found most frequently in the site-specific data and their frequency of occurrence (percent) include toluene (60 percent), ethyl benzene (44 percent), 1,1,1-trichloroethane (41 percent), xylene (37 percent), isopropyl alcohol (37 percent), and trichloroethylene (33 percent). Halogenated compounds were present in more than 60 percent of the waste streams for which composition data were available. It should also be noted that the list of major constituents present in the waste streams examined agrees well with the list of the types of solvents recycled at the facilities surveyed by the NASR.

Three of the four solvents used in the analyses of control technologies are the same as were used at proposal (toluene, MEK, and 1,1,1 trichloroethane). Methylene chloride was added to the list of constituents to provide a broader, more comprehensive range of solvent volatilities for the analyses. Methylene chloride is at the lower end of the boiling point range and is therefore more difficult to condense than are most other solvents. Therefore, the technical feasibility and costs of applying the recommended control techniques were evaluated for constituents representing the range of characteristics of commonly recycled solvents at TSDF.

5.2 MODEL PLANT EMISSION ESTIMATES

Comment: Several commenters believe that EPA has overestimated model plant emissions and question the methodology and supporting assumptions for the estimate of 86 Mg/yr (95 ton/yr) of VO per facility and the 8 Gg/yr (882,000 ton/yr) typical reclamation rate. Commenter AESP-00019 criticizes the reclamation rate but provides no supporting data. Commenters AESP-L0001 and AESP-L0017 object to the assumption that one-half of the WSTF will have process vent emissions of about 3.2 kg/h (7 lb/h) and the other half will have emissions of about 34 kg/h (75 lb/h) because the effect of controls already applied is not considered. Commenters AESP-00009, AESP-L0001, and AESP-00028 ask why no actual data were used as the basis of the environmental impact estimates and what facilities were studied to form the basis of these estimates. In support of their contention that emissions are overestimated, Commenter AESP-00009 cites a test at their Menomonee Falls, Wisconsin, facility on the product receiving tank, waste feed tank, recirculation tank, and bottoms receiving tank that shows a total emission rate of 0.805 Mg/yr (0.887 ton/yr) if operations were conducted 24 h/day for 365 day/yr. This measurement reflects one of three runs in a typically large Luwa still sized at 4 m^2 (43 ft^2); the material run was 50 percent toluene. Commenter AESP-00016 also cites air monitoring results at one facility that indicate outdoor concentrations up to 3 ppm across the street from the facility.

Commenter AESP-L0001 also states that it is not appropriate to apply to TSDF the fugitive emission factors that were developed to estimate leaks from a typical hydrocarbon plant because they do not relate to the design, operating conditions, maintenance practices, or controls associated with the processing of toxic chemical wastes.

Response: With regard to the model plant annual production rate, the industry profile referred to in response to comments 3.2.1 and 5.1 includes a frequency distribution of the waste processed in gallons during 1985. Of 448 facilities in the Screener Survey reporting solvent recovery by batch distillation, fractionation, or steam stripping operations involving some form of waste at the facility, 365 reported the total quantity of waste (all types, including waste categories other than solvents) recycled in 1985. The median facility throughput was slightly more than 189,000 L (50,000 gal); and the mean throughput was about 4.5 million L/yr (1.2 million gal/yr). These figures exclude one plant that reported more than 439 million L (116 million gal) of wastes recycled through its solvent recovery units in 1985 because the waste volume reported was almost an order of magnitude greater than the volume reported by any other facility.

Based on the industry profile frequency distribution, three sizes of model units (small, medium, and large) were defined to facilitate the analyses of control costs, emission reductions, health risks, and economic impacts. Table 5-1 presents the model unit parameters, including general plant operation characteristics and vent stream emission characteristics. The bases for the model unit parameters are presented in Docket No. F-90-AESF-FFFFF, item S0037. As can be seen in Table 5-1, for each model unit, several emission rates were chosen. The organic emission rates are based on emission source testing conducted for EPA and summarized in Docket No. F-90-AESF-FFFFF, item S0021. The organic emission rates for primary condensers varied from a few hundredths of a kg (lb) to nearly 4.5 kg/h (10 lb/h) with six of the nine measurements less than 0.45 kg/h (1 lb/h). The two secondary condensers tested showed emission rates of 0.9 and 2.3 kg/h (2 and 5 lb/h). The analysis of emission factors is discussed further in the response to comment 5.3.

The test reports reviewed include the test cited by Commenter AESP-00009; however, the emission rate of 0.805 Mg/yr (0.887 ton/yr) is derived from ambient monitoring results; therefore, it does not represent a process vent emission rate and was not used in developing the model unit

TABLE 5-1. MODEL UNIT: PROCESS VENT EMISSIONS

Item	WSTF model units		
	Large	Medium	Small
General plant operation			
Waste solvent Throughput[a]			
Mg/yr	8,000	160	32
gal/yr	2.5 x 10^6	50 x 10^3	10 x 10^3
gal/hr	600	24	4.8
L/m	38	1.5	0.3
Operating hours[b]	4,160	2,080	2,080
Process vent stream[c] cases	1. Toluene (110 °C) 2. MEK (79 °C) 3. 1,1,1-Trichloroethane (74 °C) 4. Methylene chloride (40 °C)	1. Toluene (110 °C) 2. MEK (79 °C) 3. 1,1,1-Trichloroethane (74 °C) 4. Methylene chloride (40 °C)	1. Toluene (110 °C) 2. MEK (79 °C) 3. 1,1,1-Trichloroethane (74 °C) 4. Methylene chloride (40 °C)
Vent stream emission characteristics			
Temperature[d]	24 °C	24 °C	24 °C
Flow rate[e]			
(acfm)	0.3	1.2	0.6
(L/s)	3.9	0.6	0.3
Emission factors[f] (lb/hr)			
(1)	0.4	--	--
(2)	4.2	0.17	--
(3)	10.6	0.42	0.06
(4)	--	1.20	0.24
(5)	--	5.00	1.00

MEK = Methyl ethyl ketone.
TO = Total organics.

[a] Model plant throughputs are based on information contained in the Screener Survey.

[b] Hours of operation for the large model unit are the same as those used at proposal: Intermittent operation at 2 shifts per day, 5 days per week, and 52 weeks per year. For the other model units, operating hours recommended are based on a review of facility-specific data collected in response to Section 3007 questionnaires; only eight (8) operating times were reported. The 22 TSDF plant trip reports did not contain any information regarding annual hours of operation.

(continued)

TABLE 5-1 (continued)

---

[c] Constituents selected for analysis are considered to be representative of the industry; selection was a subjective judgment based on review of relevant information and literature that included the NASR survey as well as numerous site-specific plant trip reports. Three of the solvents are the same as were used at proposal. Methylene chloride was added to the list of solvents for analysis in order to provide a more realistic range of volatilities for the condenser analysis. Methylene chloride is at the lower end of the boiling point range and is therefore more difficult to condense (worst-case). Gas streams are assumed to consist of organics and a noncondensible gas (air). The numbers in parentheses are boiling points.

[d] Temperature is the same as at proposal; a review of site-specific data confirms the appropriateness of the value selected.

[e] Flow rates are based on a review of site-specific data from 16 units in the plant visit reports. The large and medium model unit flow rates selected also agree with the SOCMI Distillation NSPS BID Cases 1 and 2; Case 5 was used in the proposal analysis. The flow for the small model unit is a subjective judgment based on the field data from WSTF.

[f] Organic emission factors are based on plant source test data contained in the site visit reports conducted for EPA by the Research Triangle Institute (RTI), Engineering Science, Radian, and other contractors. There were three groupings of test results that led to the selection of the factors at 0.1, 2.5, and 7.0 g of organics per kilogram of solvent treated. The 1.0-g factor was added as an intermediate to cover the wide range between the lower two groupings; the 30.0-g factor was added to provide an upper end value for the medium and small model units to bring overall emissions into line with the actual emission rates on a mass per time (kg/h) basis and to provide an additional high value for the cutoff determination. These values compare reasonably well to the range of values used in the AP-42 emission factor, 0.26 to 4.17 g/kg.

emission rates. Similarly, the ambient monitoring results cited by Commenter AESP-00016 are not appropriate for defining process vent emission factors.

The EPA does not agree with the statement of Commenter AESP-L0001 concerning the appropriateness of applying fugitive emission factors to TSDF that were developed to estimate leaks from a typical hydrocarbon plant. As is pointed out in the response to comment 3.2.7, the data used in establishing the fugitive emission standards for TSDF are based on emission and process data collected at a variety of petroleum refinery and SOCMI operating units. The EPA's IERL coordinated a study to develop information on fugitive emissions in the SOCMI. A total of 24 chemical process units were tested; these data covered thousands of screened sources (pumps, valves, flanges, etc.) and included process units handling such chemicals as acetone/phenol, MEK, ethylene dichloride, 1,1,1 trichloroethane, trichloethylene, and perchloroethylene (Docket No. F-90-AESF-FFFFF, item S0009). Refinery studies on fugitives also included tests on units handling both toluene and xylene (Docket No. F-90-AESF-FFFFF, items S0001 through S0005). These same chemicals are included in those listed by the NASR as solvents commonly recycled by member facilities and are found in other sources of waste solvent constituent information, as described in the response to comment 5.1. The chemicals commonly recycled at TSDF are those produced in SOCMI operating units and handled in petroleum refineries, and the equipment involved in these industries are typically the same (i.e., pumps, valves, etc.). Therefore, it is reasonable to conclude that similar design, operating conditions, maintenance practices, and controls are applied and that the emissions associated with these chemicals and equipment are similar.

5.3 FLOW RATE

Comment: Commenter AESP-00016 questions the application to WSTF of the 12 L/s (26 scfm) primary condenser exhaust gas flow rate developed initially for the conditions and materials in the chemical manufacturing industry. Recalculation of emissions using the measured emission ratio of 1.7 g/kg in the EPA Source Assessment report (EPA-600/2-78-004f) instead of the SOCMI distillation data results in an overall rate of 1,300 Mg or less than 3 million lb/yr. Emissions from solvent recycling operations generally are low according to the commenter because most systems are closed.

Response: The EPA agrees that the flow rate of 12 L/s (26 scfm) is not generally valid for application to all spent solvent recyclers. As is discussed in response to comment 5.2, small, medium, and large model units were defined to facilitate the analyses of control costs, emission reductions, health risks, and economic impacts. The flow rates specified for the model units are 3.9, 0.6, and 0.3 L/s (8.3, 1.2, and 0.6 scfm) for the large, medium, and small model units, respectively. These are based on a review of site-specific data from 16 units documented in site visit reports. The large and medium model WSTF/TSDF process vent unit flow rates also agree with the SOCMI Distillation NSPS BID (see Docket No. F-90-AESF-FFFFF, item S0013) concerning Cases 1 and 2 (for characterization of distillation unit with low overhead gas flows); Case 5 (the average for low, medium, and high flows) was used in the proposal analysis for the WSTF standard impacts.

The commenter's primary concern seems to be with the upper limit emission rates (based on SOCMI distillation data) used in the proposal analysis. In specifying the small, medium, and large model units, revised emission factors were developed. The organic emission factors are based on emission source test data from tests conducted for EPA. There were three groupings of emission factors: one group from 0.02 to 0.18 g organics/kg total organics (TO); another at 2.5 g/kg TO; and a third from 6.0 to 7.7 g/kg TO. These groupings led to the selection of emission factors at 0.1, 2.5, and 7.0 g/kg of solvent treated. A 1.0 g/kg factor was added as intermediate to cover the wide range between the lower two groupings; this allowed an additional value in the health risk and cost analyses and aided in the cutoff determination for large- and medium-sized units. A 30.0-g/kg TO factor was used to provide on upper end value for the medium and small model units and to provide an hourly emission rate (model unit hourly emission rates can be derived using the throughput and operating hours presented in Table 5-1) comparable to the measured emission rates in terms of mass per unit time (e.g., lb/hr). (Docket No. F-90-AESF-FFFFF, item S0021.) The revised range of emission factors is comparable to the range of 0.26 to 4.17 g/kg used to derive the average AP-42 emission factor for waste solvent reclamation of 1.7 g/kg.

The minimum and maximum uncontrolled emission factors for the small, medium, and large model units were applied to the frequency distribution of waste throughput referred to in the response to comment 5.2 to generate lower bound and upper bound nationwide estimates of uncontrolled process vent emissions (see Appendix C). The estimated nationwide uncontrolled process vent organic emissions range from 300 to 8,100 Mg/yr (330 to 8,900 ton/yr). The large range in uncontrolled process vent organic emissions is due to the range of primary condensers' removal efficiencies and the use of secondary condensers on some primary condenser vents.

5.4 ADJUSTMENT FOR VOLATILITY

Comment: Commenter AESP-00034 asks why no adjustment was made to emission factors, model units, or model facilities (and subsequent risk and cost analyses) to account for volatility. Several commenters (AESP-00035, AESP-L0025, and AESP-00016) submit information on the volatility of materials in the streams in support of this comment. They point out that benzene has a relatively high volatility of 8.3 kPa at 116 °C (1.2 psia at 60 °F) or 22.7 kPa at 38 °C (3.3 psia at 100 °F). However, the volatilities of the three constituents used for the model facilities are toluene's 2.1 kPa at 16 °C (0.3 psia at 60 °F), MEK's 8.3 kPa at 16 °C (1.2 psia at 60 °F), and 1,1,1-trichloroethane's 11.0 kPa at 16 °C (1.6 psia at 60 °F). According to Commenters AESP-00030, AESP-L0025, AESP-00016, and AESP-L0017, risks as well as emissions are overestimated by not accounting for differences in vapor pressure. Commenters AESP-00030 and AESP-L0025 also state that EPA should reestimate costs based on excluding nonvolatiles because only a marginal risk reduction is achievable at a very high cost.

Response: The EPA agrees that the standards should take component volatility into consideration. As is stated in the response to comment 3.2.6, previous EPA and industry studies have shown that the volatility of stream components, as a process variable, does correlate with fugitive emission rates. Analyses of the vapor pressures and emission rates has shown that substances with vapor pressures of 0.3 kPa or higher had significantly higher emission rates than did those with lower vapor pressures (Docket No. F-90-AESF-FFFFF, items S0001 through S0009). This result led to the separation of equipment component emissions by service: gas/vapor, light liquid, and heavy liquid. These classifications have been used in most fugitive emission standards to effectively direct the major effort toward equipment most likely to leak. Therefore, the rules have been revised to account for volatility. For example, pumps and valves in heavy liquid service must be monitored only if evidence of a potential leak is found. Light and heavy liquid service are based on the vapor pressure of the components in the stream (less than 0.3 kPa at 20 °C defines a heavy liquid).

All of the constituents used in the WSTF model unit analysis, representing the ranges of characteristics of commonly recycled solvents, are light liquids to which the benzene and SOCMI fugitive emission factors are applicable. Therefore, the revised risk and cost analyses related to WSTF equipment leak fugitive emissions are based on the fugitive emission factors used in the proposal analyses, although a medium and a small model unit have been added. The analyses of risk and cost impacts on TSDF with affected fugitive emission sources were revised to account for the differences in light and heavy liquids. Nationwide fugitive emissions and control costs for TSDF fugitive sources were estimated using a computerized model developed to aid in the analyses supporting the additional TSDF air emission standards. The computerized model, which is described in Appendix D, was used to estimate TSDF fugitive emissions and control costs because it can access the TSDF industry profile developed for the analysis of the additional standards to identify facilities handling light liquid hazardous wastes with greater than 10-percent organic content. The model also accounts for throughput in generating control cost estimates. The results of the revised risk and cost analyses are presented in Chapters 6.0 and 8.0, respectively.

5.5 NUMBER OF FACILITIES

Comment: Commenter AESP-00015 contends that the proposed rules will affect more than the 100 WSTF estimated in the preamble because small solvent recovery stills that are commonly part of industrial degreasing operations are not accounted for.

Response: The EPA agrees that the standards will affect more than the 100 WSTF. At proposal, EPA estimated the number of WSTF potentially affected by the standards based on the nationwide volume of waste solvent requiring management. The EPA's estimate also included extension of the proposed standards to approximately 1,300 TSDF (the midpoint of an estimated range of 269 to 2,332 facilities) that handle hazardous waste streams or derivatives with at least 10 percent organics. Since proposal, EPA has identified 448 onsite and offsite waste solvent recyclers. The EPA estimates that a total of about 1,400 onsite and offsite TSDF, including TSDF that practice solvent recovery, manage light liquid hazardous waste streams containing 10 percent or more total organics and would be subject to LDAR requirements.

The final standards contain a facility process vent emission rate limit of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) of organic emissions. The EPA's estimates based on the high emission rates and 1985 waste solvent throughput data indicate that about 45.5 percent of the WSTF identified in the industry profile will have process vent emissions of less than 2.8 Mg/yr (3.1 ton/yr). Therefore, it is anticipated that the small solvent recovery stills to which the commenter refers would not be affected by the process vent standards.

5.6 ADEQUACY OF DATA AND INFORMATION SUPPORTING THE IMPACT ANALYSES

Comment: Commenters AESP-00019 and AESP-00029 state that the proposed rules should be limited to process vents for reclaimers because the BID does not adequately address or evaluate the impacts from TSDF sources.

Response: At proposal, EPA concluded that the proposed standards for WSTF could be broadened to cover all equipment handling TSDF hazardous waste streams with at least 10 percent organics. There is no technical basis for limiting the proposed controls to equipment at only solvent treatment operations. The revised impact analyses conducted by EPA include a facility-specific analysis for both WSTF (448 facilities) process vent and associated fugitive (equipment leak) emissions, and for TSDF (1,428 facilities) fugitive emissions associated with those waste management processes other than solvent recovery type processes that handle light liquid hazardous waste streams with at least 10 percent organics. The revised impact estimates do not include estimated emissions or health risks associated with process vents at TSDF not engaged in distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operations. Data are insufficient at this time to provide such estimates. Therefore, EPA is limiting the applicability of the process vent standards; only process vents on operations involved in solvent or other organic chemical reclamation or waste treatment separation or removal by distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping of hazardous wastes with total organics concentrations of at least 10 ppmw are subject to the promulgated rules. Emission controls for other TSDF processes, area sources, and waste categories are under development and are scheduled to be proposed in 1989 under a separate rulemaking. However, TSDF with valves and pumps containing or contacting hazardous waste with at least 10 percent organics and otherwise required to obtain a RCRA permit are covered by the LDAR requirements of this standard.

6.0 HEALTH RISK IMPACTS

6.1 REPRESENTATIVENESS OF WASTE STREAMS

Comment: Commenters AESP-00016 and AESP-00034 object to the lack of information on the composition of emissions and the analysis of only three pollutants for WSTF and a fourth for TSDF. Numerous commenters also believe that the constituents analyzed do not fairly represent the material in recycled streams. Commenters AESP-00004 and AESP-00005 state that within the solvent recycling industry the waste streams do not contain toxics or volatiles, and treatment operations do not change the character of the wastes. In support, Commenter AESP-00016 submits an informal survey of the materials handled by commercial recyclers that shows halogenated solvents (including perchloroethylene) but no listed carcinogens. Commenter AESP-00004 agrees, adding that these facilities do not produce emissions with PCBs, dioxins, acids, reactives, pesticides, or other highly carcinogenic compounds.

Response: At proposal, EPA believed that the types of streams in the TSDF industry had similar characteristics to those found in the synthetic organic chemical manufacturing industry (SOCMI). In an effort to provide further information and data on the composition of waste streams treated at WSTF/TSDF and the associated air emissions, EPA has conducted a review of the available information regarding WSTF/TSDF waste streams constituents and concentrations. The EPA TSDF Waste Characterization Data Base (WCDB), information from numerous plant trip reports, and data from a limited number of emission test reports were used to characterize waste streams treated by WSTF and TSDF in terms of volatilities, concentrations of components, and unit risk factors (Docket No. F-90-AESF-FFFFF, item S0047). The selection of the range of unit risk factors used in the risk analysis is discussed in Section 6.2.

Plant-Specific Data

Plant trip reports and emission test reports from site visits, conducted in connection with the evaluation of organic removal through pretreatment processes, provided organic composition and concentration data for 22 waste stream cases from 16 WSTF/TSDF. The most obvious conclusion to be reached from an examination of these stream data is that WSTF waste streams are not readily characterized. With regard to total organic content (TOC), the examined WSTF waste streams, treated for solvent recovery, varied from less than one (1) percent TOC to practically 100 percent TOC. Of the 19 cases that reported a value for waste stream TOC content, five (5) were less than one (1) percent, six (6) were from one (1) to 25 percent, (four) 4 were between 25 and 90 percent, and four (4) were greater than 90 percent TOC. It is important to note that two of the feed waste streams with TO concentrations of less than 1 percent generated overhead vapor and condensate streams, when steam stripped, with a TOC of greater than 10 percent. Therefore, a waste stream TOC is not a totally reliable index or indicator of vent streams that exceed 10 percent total organics.

In general, the stream contents were comprised of one or two major constituents with two or more minor constituents. The constituent that showed up most frequently in the site-specific data was toluene, which was reported as being present in about 55% of the streams examined. Toluene concentrations, however, were typically less than one (1) percent but did range up to 50 percent of feed content. Other major constituents and their percent occurrence included MEK (36%), acetone (32%), xylene (27%), ethyl benzene (36%), isopropyl alcohol (36%), methylene chloride (32%) 1,1,1 tricholoroethane (45%), trichloroethylene (36%) chloroform (18%), tetrachloroethylene (18%), and carbon tetrachloride (23%). Table 6-1 summarizes the most commonly occurring constituents.

Halogenated compounds were present in more than 68 percent of the waste streams for which composition data were available. It also should be noted that the list of major constituents present in the 22 waste streams examined agrees well with the list of the types of solvent recycled at the facilities surveyed by the National Association of Solvent Recyclers. (Docket F-86-AESP-FFFFF, item L0014).

TABLE 6-1. SUMMARY OF WSTF/TSDF WASTE STREAM CONSTITUENTS[a]

Constituent	Frequency of occurrence,[a] %	Concentration range (weight %)
Toluene	55	0.4 - 50
Ethyl benzene	36	0.1 - 11.4
1,1,1-Trichloroethane	45	0.3 - 100
Xylene	27	5.9 - 49.2
Isopropyl alcohol	36	0.2 - 42.9
Trichloroethylene	36	0.2 - 8.0
Methyl ethyl ketone	32	0.2 - 60.0
Acetone	32	21 - 74
Methylene chloride	30	0.3 - 40
Chloroform	18	0.03 - 4
Tetrachloroethylene	18	0.6 - 3.0
Carbon tetrachloride	23	0.2 - 0.5

[a] For 22 waste streams from 16 WSTF/TSDF.

As regards constituent concentrations, for nonhalogenated organics there were no perceivable patterns; both high and low constituent concentrations were observed. For halogenated compounds, constituent concentrations tended to be quite low (i.e., generally less than one (1) percent of the waste stream), the two exceptions being methylene chloride and 1,1,1-trichloroethane which did show up in very high concentrations in a few cases (see Table 6-1). No discernible connection was observed between TOC and the presence of individual constituents.

With respect to volatility, it is useful to look at vapor pressure and boiling point (see Table 6-2) in comparison to benzene since EPA has based its regulatory approach for the TSDF equipment leak standards on existing standards issued under Section 112 of the CAA for control of benzene emissions. Of the 12 major constituents previously listed in Table 6-1, six (6) have vapor pressures greater than and boiling points less than benzene (95 mm Hg and 80 °C, respectively): MEK, acetone, methylene chloride, 1,1,1 trichloroethane, chloroform, and carbon tetrachloride. It could, therefore, be concluded that organic constituents treated at WSTF do tend to be moderately to highly volatile chemicals.

Of the chemical constituents reported as present in the 22 WSTF waste stream cases, the only ones having established unit risk factors were the halogenated organics. For the halogenated organics that were mentioned above as being major actors, the unit risk factors ranged from 1.5×10^{-5} $(\mu g/m^3)^{-1}$ for carbon tetrachloride to 4.7×10^{-7} $(\mu g/m^3)^{-1}$ for methylene chloride. This range agrees most favorably with the range of unit risk factors used at proposal, 2×10^{-5} to 2×10^{-7} $(\mu g/m^3)^{-1}$. The one notable addition to the list was 1,2-dichloroethane [2.6×10^{-5} $(\mu g/m^3)^{-1}$], which appeared in only one case.

Testing of vent emissions has been conducted at a number of sites in connection with the evaluation of organics removal through pretreatment processes. However, plant trip reports and emission test reports at six (6) sites provided the organics composition and concentration data in the detail required for this analysis. Table 6-3 presents a summary of vent emissions test results from these sites. The information in this table is the total quantified organics in each vent stream. The site numbers are the identifiers used by EPA. Sites 20, 3, 22, and 0 are chemical

TABLE 6-2. INFORMATION FOR TSDF CONSTITUENTS[a]

Compound name	Molecular weight	Vapor pressure, mm Hg	Boiling point, °C	Unit risk value, $(\mu g/m^3)^{-1}$
1,2-Dichloroethane	99.0	80	83.4	2.6×10^{-5}
1,1,1-Trichloroethane	133.40	123	81.0	
Acetaldehyde	44.05	760	20.8	2.2×10^{-6}
Acetic acid	60.05	15.41	118.0	
Acetone	58.08	266	56.2	
Acetonitrile	41.03	90	81.6	
Acrylonitrile	53.06	114	77.4	6.8×10^{-5}
Aniline	93.10	1	184	7.4×10^{-6}
Benzene	78.10	95.2	80.1	8.3×10^{-6}
Benzyl chloride	126.60	1.21	179.4	
Bisphenol (A)	228.31			
Butanol-1	74.12	6.5	117.7	
Butyl cellosolve	118.20	1.61	170.0	
Carbon disulfide	76.14	366	46.3	
Carbon tetrachloride	153.80	113	76.8	1.5×10^{-5}
Chlorobenzene	112.56	11.8	132.0	
Chloroform	118.40	208	61.2	2.3×10^{-5}
Chlorotoluene	126.60	2.8	162.0	
Cresol	108.13	0.3	195.0	
Cumene (isopropylbenzene)	120.20	4.6	153.0	
Cyclohexanone	98.15	4.8	157.0	
Dichlorobenzene (1,2)	147.00	1.5	179.0	

(continued)

TABLE 6-2. (continued)

Compound name	Molecular weight	Vapor pressure, mm Hg	Boiling point, °C	Unit risk value, $(\mu g/m^3)^{-1}$
Dimethyl formamide	73.09	3.995	152.8	
Ethanol	46.10	50	78.4	
Ethyl acetate (I)	88.10	100	77	
Ethyl benzene	106.16	10	136.2	
Ethylene glycol	62.07	1.11	198.0	
Formic acid	46.00	1.22	100.7	
Freon	120.92	5,000	-29.8	
Furan	68.08	596.207	31.4	
Furfural (I)	96.09	2	161.7	
Heptane	100.02	48	98.4	
Hexane	86.20	150.3	69.0	
Isopropanol	60.09	42.8	82.4	
Methanol	32.04	114	65.0	
Methyl acetate	74.10	235	54.0	
Methyl acrylate	86.10			
Methyl ethyl ketone	72.12	100	79.6	
Methyl isobutyl ketone	100.16	15.7	115.8	
Methyl (A) styrene	236.18			
Methylene chloride	85.00	438	39.8	4.7×10^{-7}
Morpholine	87.12	10	129.0	
Nitrocellulose	10,000			
Phenol	94.10	0.341	182.0	

(continued)

TABLE 6-2. (continued)

Compound name	Molecular weight	Vapor pressure, mm Hg	Boiling point, °C	Unit risk value, $(\mu g/m^3)^{-1}$
Polybutadiene	1,000.00			
Polypropylene	20,000.00			
Polyvinyl alcohol	120,000.00			
Propyl acetate	102.13	35	101.6	
Sodium hydroxide	40.00			
Styrene	104.20	7.3	145.0	
Tetrachloroethylene	165.83	19	121.4	5.8×10^{-7}
Toluene	92.00	30	110.6	
Trichloroethylene	131.39	75	87.0	1.7×10^{-6}
Triethylamine	101.22	400		
Urethane	89.09	10	-40.3	
Vinyl acetate	86.09	115	73.0	
Xylene	106.20	8.5	144.4	

[a] Constituents representing at least 1 percent of the composition of EPA hazardous waste streams F001-F005 and D001 contained in the ISDB and Illinois EPA data base for which properties were available.

TABLE 6-3. VENT EMISSIONS CONSTITUENT DATA SUMMARY FOR STEAM STRIPPER AND DISTILLATION UNITS, mg/L

	Site 20[a] condenser vent	Site 3[c] condenser vent	Site 21 batch 1[d] condenser vent	Site 21 batch 2[d] condenser vent	Site 22 receiver vent	Site 25[f] unit 1 condenser vent	Site 25[d] unit 2 condenser vent	Site 0[e,f] primary condenser vent
Vinyl chloride	32	NA	NA	NA	NA	NA	NA	NA
Chloroethane	17	NA	NA	NA	NA	NA	NA	NA
1,1 Dichloroethane	14	NA	NA	NA	NA	NA	NA	NA
1,1 Dichloroethane	4.8	NA	NA	NA	NA	NA	NA	NA
1,2 Dichloroethane	3.4[g]	NA	NA	NA	NA	NA	NA	NA
Chloroform	41	NA	NA	NA	0.41	NA	0.12[h]	222
1,2 Dichloroethane	130	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	<0.015	NA	NA	NA	NA	NA	NA
2-Nitrotoluene	NA	<0.015	NA	NA	NA	NA	NA	NA
4-Nitrobenzene	NA	<0.015	NA	NA	NA	NA	NA	NA
1,5 Hexadiyne	NA	1.4	NA	NA	NA	NA	NA	NA
Toluene	NA	0.41	6.7	0.14	NA	NA	NA	NA
Methyl ethyl ketone	NA	NA	7.7	36	NA	49	<0.1	NA
Isopropanol	NA	NA	1.9	NA	NA	NA	<0.1	NA
Tetrachloroethylene	NA	NA	1.0	NA	NA	NA	NA	NA
1,1,1 Trichloroethane	NA	NA	1.8	110	NA	NA	NA	NA
Xylene	NA	NA	3.4	0.47	NA	NA	NA	NA
Ethylbenzene	NA	NA	1.5	NA	NA	NA	NA	NA
Methylene chloride	NA	NA	NA	1.0[h]	4.4	NA	<0.1	1,480
Carbon tetrachloride	NA	NA	NA	NA	0.15	3.8[i]	NA	1,440

(continued)

TABLE 6-3. (continued)

	Site 20[a] condenser vent	Site 3[c] condenser vent	Site 21 batch 1[d] condenser vent	Site 21 batch 2[d] condenser vent	Site 22 receiver vent	Site 25[f] unit 1 condenser vent	Site 25[d] unit 2 condenser vent	Site 0[e,f] primary condenser vent
Acetone	NA	NA	NA	NA	NA	19[h]	1.1	NA
2,2 Dimethyl oxirane	NA	NA	NA	NA	NA	120[h]	NA	NA
Methanol	NA	NA	NA	NA	NA	3.8[j]	NA	NA
Chloromethane	NA	NA	NA	NA	NA	NA	NA	14.1
Total quantified organics	240	1.8	24	150	5.0	200	1.2	3200
Composite unit risk factor,[k] $(\mu g/m^3)^{-1}$	2.1×10^{-5}	0	2.4×10^{-8}	3.1×10^{-9}	2.8×10^{-6}	2.9×10^{-7}	2.3×10^{-6}	8.6×10^{-6}

NA = Not analyzed for

[a] average of six measurements.
[b] average of five measurements.
[c] average of three measurements.
[d] average of four measurements.
[e] average of eight measurements
[f] secondary condenser vent concentrations were similar.
[g] two measurements of <2.0 mg/L averaged in as zero.
[h] one measurement of <0.1 averaged in as zero.
[i] three measurements of <0.1 averaged in as zero.
[j] two measurements of <0.1 averaged in as zero.
[k] weighted average based on constituent concentration. The overall weighted average for all sites is 8.5×10^{-6} $(\mu g/m^3)^{-1}$.

manufacturers that strip organics from wastewater both for recycling and as wastewater treatment. Sites 21 and 25 are organic solvent recyclers.

Table 6-4 provides a summary of the ranges of constituent concentrations and frequencies of occurrence for the tests presented in Table 6-3.

Waste Characterization Data Base

The most comprehensive source of waste characterization information is the TSDF waste characterization data base (WCDB). As described in Appendix D, to support the development of comprehensive air emission regulations for hazardous waste TSDF, hazardous wastes were characterized by merging the following five existing data bases:

- National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities Data Base
- Industrial Studies Data Base (ISDB)
- Listing documentation of 40 CFR 261.32 hazardous wastes from specific sources (i.e., waste codes beginning with the letter K)
- WET Model Hazardous Waste Data Bases
- A data base created by the Illinois EPA.

Of these five data bases, the best sources of constituent and percent composition of constituent information were the ISDB and Illinois EPA data bases.

Generic spent solvent waste streams include EPA hazardous wastes F001-F005. In addition, information from the Screener Survey indicates that D001 wastes (ignitable) are also recycled by commercial waste solvents recyclers. Therefore, information characterizing F001-F005 and D001 waste streams was extracted from the ISDB and Illinois EPA data bases.

The ISDB is a compilation of data from ongoing, in-depth EPA/OSW surveys of designated industries that are major hazardous waste generators. The ISDB currently addresses only 18 SIC codes. Data were gathered from detailed questionnaires completed by industry, engineering analyses, and a waste sampling/analysis program. The data base contains detailed TSDF information on a site-by-site basis. Due to the confidential nature of much of the data, waste information was aggregated.

The Illinois EPA Data Base contains information from permit applications. Each hazardous and special nonhazardous waste stream managed in the State of

TABLE 6-4. VENT EMISSIONS CONSTITUENT RANGE AND FREQUENCY

Compound	Range, mg/L	Frequency[a]
Vinyl chloride	32	1
Chloroethane	17	1
1,1 Dichloroethene	14	1
1,1 Dichloroethane	4.8	1
1,2 Dichloroethene	3.4	1
1,2 Dichloroethane	130	1
Chloroform	0.12 - 222	4
Tetrachloroethylene	1.0	1
1,1,1 Trichloroethylene	1.8 - 110	2
Methylene chloride	1.0 - 1480	3
Carbon tetrachloride	0.15 - 1440	3
Chloromethane	14.1	1
1,5 Hexadiyne	1.4	1
Toluene	0.14 - 6.7	3
Methyl ethyl ketone	7.7 - 49	3
Isopropanol	1.9	1
Xylene	0.47 - 3.4	2
Ethylbenzene	1.5	1
Acetone	1.1 - 19	2
2,2 Dimethyl oxirane	120	1
Methanol	3.8	1

[a] Times observed at quantifiable levels out of a possible seven occurrences.

Illinois must be permitted through the Division of Land/Noise Pollution Control. Generators must submit one application for each waste. To date, the data base contains about 35,000 permits. An analysis of each waste must be provided with each permit application.

An examination of the D001 and spent solvent waste stream information in the Illinois EPA Data Base indicates the same general trends as noted for the plant-specific data; i.e., in general the waste streams were composed of one or two major constituents with two or more minor constituents present in lesser amounts. The D001 streams tend to have a wider range of constituents than the spent solvent streams. The major constituents included those listed for the plant-specific data as well as perchloroethylene, freon, and mineral spirits.

Organic constituent concentrations in the ISDB and Illinois EPA data base range from less than one-half percent to 100 percent. To identify constituents representing the range of properties characteristic of recycled waste, constituents found in F001-F005 and D001 wastes in concentrations greater than 1 percent were extracted from the data bases. This produced a listing of more than 100 constituents. Properties for 57 of these constituents were available in the literature. Table 6-2 presents a listing of these 57 constituents and available information on properties (molecular weight, vapor pressure, boiling point and unit risk factor). Molecular weights range from 32.04 (methanol) to 120,000 (polyvinyl alcohol); vapor pressures from 0.3 mm Hg (cresol) to 5,000 mm Hg (freon); boiling points from -40.3 °C (urethane) to 195 °C (cresol); and unit risk factors (for 10 constituents) from 4.7×10^{-7} $(\mu g/m^3)^{-1}$ (methylene chloride) to 6.8×10^{-5} $(\mu g/m^3)^{-1}$ (acrylonitrile). Again, the wide range of constituent properties indicates the difficulty in characterizing WSTF waste streams, however, the constituents chosen for the model unit analysis have properties spanning the range of properties of most of the constituents from the ISDB and Illinois EPA data base.

Conclusion

The waste constituents selected for use in analysis of the process vent standards were toluene, methyl ethyl ketone, 1,1,1-tricholoroethane, and methylene chloride. Their selection was a subjective judgment based on review of the information and data presented above. Three of these solvents are the same as were used at proposal. Methylene chloride was added to the list of solvents for analysis in order to provide a broader, more comprehensive range of chemical and physical properties. Thus, based on the available data regarding waste solvent compositions and concentrations, EPA concluded that the chemical constituents used in the post-proposal analysis for process vents are representative of the constituents found at waste solvent treatment facilities.

6.2 UNIT RISK FACTORS

Comment: Four commenters (AESP-L0001, AESP-00009, AESP-00016, AESP-L0008, and AESP-L0016) object to the procedures associated with the application of unit risk factors. In support, Commenter AESP-L0001 points out that the BID lists 26 chemicals likely to be covered by the land ban regulations, but only 4 have unit risk factors and are used in the analysis. The remaining 22 chemicals are not currently considered to be carcinogens, although some are under review as potential hazardous air pollutants. The analysis assumes, however, that all of the emissions have a risk comparable to methylene chloride at the lower bound, and all of the emissions have a risk comparable to carbon tetrachloride at the upper bound. Also, the use of unit risk factor estimates calculated for trichloroethylene, tetrachloroethylene, and methylene chloride as though they posed a human cancer risk is unjustified. Commenter AESP-L0008 believes that the failure to address the weight of evidence for carcinogenicity is inconsistent with EPA's risk assessment guidelines (51 FR 33992, September 24, 1986) and with the principles for assessing cancer risk developed by the White House Office of Science and Technology Policy (50 FR 10372, March 14, 1985). Commenter AESP-L0016 objects to the lack of support provided for the selection and derivation of unit risk factors and for the choice of carbon tetrachloride as the upper bound unit risk factor because certain chemicals that could be treated in large quantities at TSDF have a higher unit risk factor (e.g., acrylonitrile or ethylene oxide). Commenters AESP-00016 and AESP-00009 object to the risk analysis because carbon tetrachloride, selected to represent the upper bound on the range of unit risk factors, is not representative of wastes recycled at commercial facilities. Several commenters from TSDF and WSTF also state that the risk analysis is not representative of the wide variety of wastes handled.

Response: The selection of the range of unit risk factors used at proposal to estimate the cancer risk resulting from TSDF emissions was based on a review of available information regarding WSTF/TSDF waste streams. Of the chemical constituents reported as present in the actual WSTF/TSDF waste stream cases examined by EPA, the ones having established unit risk factors were the halogenated organics (including carbon tetrachloride) and nitrobenzene. In response to Commenters AESP-00016 and AESP-00009, available TSDF waste characterization data indicate the presence of carbon tetrachloride in recycled wastes in 23 percent of the waste streams examined. For the six halogenated organics that were identified as being frequently occurring constituents in WSTF waste streams (see comment 6.1), the unit risk factors for the chemicals ranged from 1.5×10^{-5} $(\mu g/m^3)^{-1}$ for carbon tetrachloride to 4.7×10^{-7} $(\mu g/m^3)^{-1}$ for methylene chloride. This range agrees most favorably with the range of unit risk factors [2×10^{-5} to 2×10^{-7} $(\mu g/m^3)^{-1}$] used at proposal for estimation of both process vent and equipment leak health risks. However, this range of unit risk factors was not used in the final analysis.

To estimate the cancer potency of TSDF air emissions in the revised analysis, an emission-weighted composite unit risk estimate approach was used by EPA to address the problem of dealing with the large number of toxic chemicals that are present at TSDF. Using the emission-weighted composite factor rather than individual component unit risk factors simplifies the risk assessment so that calculations do not need to be performed for each chemical emitted. The composite risk factor is combined with estimates of ambient concentrations of total organics and population exposure to estimate risk due to TSDF emissions. In calculating the emission-weighted average unit risk factor, the emission estimate for a compound is first multiplied by the unit risk factor for that compound; then the emission-weighted average is computed by summing these individual risk numbers and dividing the sum by the total TSDF emission value. Using this type of average would give the same result as calculating the risk for each chemical involved. However, only those carcinogens for which unit risk factors are available would be included in the analysis of cancer risk under this approach.

Through use of the EPA's TSDF WCDB and a computerized model developed for analysis of the regulatory options for TSDF emission sources (see Appendix D for a description of the model), EPA estimated total nationwide TSDF emissions by specific waste constituent. Thirty-nine chemicals were identified as TSDF organic air pollutant emission constituents emitted from equipment leaks at all types of TSDF waste management processes. Unit risk factors were then averaged based on both carcinogenic and noncarcinogenic nationwide TSDF equipment leak emissions to calculate an emission-weighted composite mean TSDF cancer unit risk factor.

With regard to the concerns of Commenter AESP-L0016, numerous constituents with higher unit risk factors than carbon tetrachloride (including acrylonitrile and ethylene oxide) were included in the calculation of the emission-weighted unit risk factor for TSDF equipment leaks. The TSDF equipment leak, emission-weighted unit risk factor value was determined to be 4.5×10^{-6} $(\mu g/m^3)^{-1}$, and was used to determine the health-related impacts associated with TSDF equipment leak (fugitive) emissions rather than using the range of the unit risk factors that represents the limited number of chemical compounds (organic solvents) emitted at WSTF. A more detailed discussion of the hazardous waste TSDF unit risk factor determination is contained in the Appendix B of this document.

Characterization of WSTF waste streams in the final analysis indicates that the constituents and range of unit risk factors used at proposal in the risk analysis are appropriate and representative of the waste solvent recycling industry. Results of the EPA waste stream characterization are discussed in the response to comment 6.1.

A similar approach to developing a composite unit risk factor for process vents was also considered for the revised impacts analysis. However, insufficient nationwide data on WSTF (a subset of the TSDF industry) waste stream chemical constituent quantities and concentrations were available to develop an emission-weighted, arithmetic mean cancer unit risk factor for WSTF process vents. As shown in Table 6-3, the composite or emission-weighted unit risk factors for individual process vent emission streams varies widely.

The WSTF waste streams and their associated process vent emissions were found to contain a variety of chemical constituents. Those constituents with established risk factors were, in all cases for the plant-specific data, the halogenated organics; these halogenated organic constituent concentrations tended to be quiet low, generally less than one (1) percent of organics emitted. Therefore, EPA judged, based on the limited data available, that use of a midrange unit risk factor would be appropriate in estimating nationwide health impacts associated with WSTF process vents. The unit risk factor assumed at proposal, 2×10^{-6} $(\mu g/m^3)^{-1}$, is the geometric midrange between the highest and lowest unit risk factors for the constituents found in the WSTF process vent streams. The unit risk factor calculated for the equipment leak emissions agrees favorably with the process vent number used at proposal. Because it is not unreasonable to assume a similar mix of constituents in process vents as from equipment leaks, and available data do not suggest otherwise, for the purpose of estimating impacts the same unit risk factor was used for both process vents and equipment leaks, 4.5×10^{-6} $(\mu g/m^3)^{-1}$. Any underestimation of risk resulting from the use of midrange risk factor for process vents would tend to be offset by applying the unit risk factor to the entire waste stream emission (i.e., all organic emissions are assumed carcinogenic) and by use of the high range (upper bound) emission factor in determining process vent emissions.

With regard to the comment that the failure to address the weight of evidence for carcinogenicity is inconsistent with EPA's risk assessment guidelines and the principles for assessing cancer risk, it should be noted that early in the rulemaking for TSDF, EPA looked at the contribution to total estimated risk (annual incidence) by weight of evidence. At that time, C carcinogens accounted for about 5 percent of the total risk, and A carcinogens about 10 percent. For all practical purposes, calculating separate risk estimates for chemicals in each weight of evidence category adds little to the risk assessment. However, the EPA "Guidelines for Carcinogen Risk Assessment" (51 FR 33992, September 24, 1986) and "Guidelines for the Health Risk Assessment of Chemical Mixtures" (51 FR 34014) do not describe a means to quantitatively incorporate weight of evidence into risk assessments. Thus, according to the guidelines, making no distinction among carcinogens regarding weight of evidence is appropriate.

6.3 METHODOLOGY

Comment: Commenter AESP-00016 challenges the methodology applied in the assessment to estimate the cancer risk to the MEI, which results in an unrealistic estimate of nationwide cancer incidence and risk that is higher than any other previous risk estimate for any EPA rulemaking. Commenters AESP-L0016 and AESP-00010 state that the assessment is questionable because the methods and procedures are inadequately described, are not based on actual data, and have never been reviewed by the Science Advisory Board, the National Air Pollution Control Techniques Advisory Committee (NAPCTAC), or industry. Commenter AESP-L0001 states that the methodology and assumptions produce a value that bears no relationship to the actual situation and recommends that OAQPS perform a detailed assessment of the specific sources and sites. Commenter AESP-L0018 does not believe that EPA has adequately analyzed whether hazardous waste TSDF pose a risk, whether the risk is significant, and what sources or sites are causing the risk.

Response: At proposal, order-of-magnitude health impacts were estimated for cancer risks from exposure to organic air emissions from WSTF and TSDF. The Human Exposure Model (HEM) (Docket No. F-90-AESF-FFFFF, item S0044) was used to calculate the magnitude of risks posed by WSTF at both typical and maximum emission rates. Based on an estimated urban/rural distribution, EPA selected six WSTF to represent the nationwide WSTF industry in performing the risk assessment. Using the results of the analysis of these "typical" facilities, health impacts were extrapolated to all WSTF and TSDF in general to provide nationwide estimates.

In the revised health impacts analysis, annual cancer incidence and MIR were again used to quantify health impacts for the control alternatives for process vents and equipment leaks. Annual cancer incidence is a measure of aggregate risk per year to the entire population exposed to TSDF emissions nationwide. It represents the sum of each individual's estimated risk to exposure to TSDF emissions, for individuals who live within a distance of 50 km of any TSDF. The MIR, on the other hand, represents the potential risk to those individuals who may live closest to the expected worst-emitting TSDF for a lifetime of 70 years. MIR is by no means representative of the entire industry, and in fact is experienced by few, if any, individuals.

However, in this followup analysis, the HEM was run using site-specific data on facility waste throughputs, emission rates, meteorology (i.e., nearest National Weather Bureau meteorology station), and 1980 census population density for each WSTF and TSDF nationwide identified in the various data bases. The facility-specific information was obtained from three principal sources. Waste quantity and solvent recycling data were taken from the 1986 National Screener Survey. Waste management processing schemes and waste types managed in each facility were based on the Hazardous Waste Data Management System's (HWDMS) RCRA Part A applications; the National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities Regulated Under RCRA in 1981 (Westat Survey); and the 1986 National Screener Survey. In addition, health impacts were evaluated using an equipment leak specific risk factor [i.e., 4.5×10^{-6} $(\mu g/m^3)^{-1}$] applicable to TSDF equipment leaks nationwide. The unit risk factor used for waste solvent recyclers was based on an analysis of the organic chemicals associated with WSTF operations; refer to comment 6.2 and Appendix B for more information regarding selection of the unit risk factors.

In revising the methodology applied in assessing cancer risks, EPA conducted facility-specific HEM computer runs for each of the 448 WSTF that reported recycling and/or reuse of solvents and other organic compounds, and for each of the more than 1,400 TSDF in the industry profile of 2,300 TSDF that were determined to manage wastes with greater than 10-percent organic content. These HEM results were used to estimate nationwide cancer incidence for both TSDF equipment leaks and process vents; the HEM results were also used in estimating the MIR or maximum risk for TSDF/WSTF process vents. For estimates of maximum risk associated with TSDF equipment leaks, a separate methodology was used.

At proposal, no attempt was made to estimate MIR for TSDF equipment leaks because of a lack of adequate site-specific information. Since proposal, the results of a multiyear project to collect information on the Nation's generation of hazardous waste and the capacity available to treat, store, dispose, and recycle that waste have become available on a limited basis. In the survey, all active treatment, storage, disposal and recycling facilities (TSDR) were sent a detailed package of questionnaires appropriate to the processes they operate. The completed questionnaires were reviewed for technical accuracy; after independent verification, the information collected was entered into a complex data base. The TSDR survey questionnaire responses contain the most detailed, up-to-date nationwide information regarding the hazardous waste management technologies each facility has on site. For each facility, detailed information are available in the data base including facility area, numbers of hazardous waste management units by process type (i.e., number of surface impoundments, incinerators, recycling units), annual throughput by process unit, and types of waste (i.e., RCRA waste codes) managed by each unit at the facility. The availability of this information in computerized format made it possible to use the TSDR survey data base to identify facilities that represent the population of worst case facilities with regard to equipment leak emissions and the potential for high individual risk (MIR) values.

The MIR estimate was made, first, by screening detailed TSDR Survey data for more than 1,400 TSDF to identify the facility that has the highest potential equipment leak emissions and the highest potential for these emissions to result in high ambient air concentrations (i.e., high emissions on a small facility area). Next, it was assumed that this facility handles hazardous wastes that have carcinogens with an emission-weighted potency equal to that of the nationwide average and that an individual was residing at the shortest distance from the TSDF management units to the nearest apparent residence. The highest annual-average ambient concentration, resulting from this high emission-rate facility, predicted to occur at the residence nearest the facility was then determined by dispersion modeling. The ISCLT dispersion model was used in the equipment leak MIR analysis to model the worst case facility as a true area source with the actual facility area of about one acre as input. The highest annual average out of the results of 5 years of meteorological data modeled for each of the eight cities used to characterize nationwide meteorology was selected for use in the MIR calculation. Thus, the MIR estimate is considered a worst-case estimate for the industry and should not be interpreted to represent the risk posed by any facility in the industry other than a worst-case facility or the risk experienced by anyone other than the theoretically most-exposed individual. A detailed discussion of the health impacts methodologies is presented in Appendix B of this document.

The results of this revised risk assessment were used as the basis for evaluation of the proposed standards and for support of changes (such as the addition of the facility process vent cutoff) that were made to the standards since proposal.

6.4 ADDITIVE AND SYNERGISTIC EFFECTS

Comment: Commenter AESP-L0016 states that the assessment is flawed because large uncertainties are introduced when the additive or synergistic effects of carcinogens and the individual variability in response is not factored in. The commenter also notes that the analysis fails to consider the substantial environmental and public health benefits in addition to cancer prevention that would result from stricter standards, such as teratogenic, neurological, immunotoxic, and respiratory effects and the benefits in ozone reduction.

Response: As noted in response to comments in Section 6.3, annual cancer incidence and MIR were the only indexes used to quantify health impacts. The EPA does recognize that other health effects may be associated with both short-term and long-term human exposure to the organic chemicals emitted to the air at WSTF/TSDF. The EPA believes, however, that a risk assessment based on cancer serves as the clearest basis for evaluating the health effects associated with exposure to air emissions from TSDF. A quantitative assessment of the potential nationwide noncancer health impacts (e.g., developmental, neurological, immunological, and respiratory effects) was not conducted due to deficiencies at this time in the health data base for these types of effects.

Although unable to numerically quantify noncancer health risks, EPA did conduct a screening analysis of the potential adverse noncancer health effects associated with short-term and long-term exposure to individual waste constituents emitted from TSDF. This analysis was based on a comparison of relevant health data to the highest short-term or long-term modeled ambient concentrations for chemicals at each of two selected TSDF. (A detailed presentation of the screening analysis is contained in Appendix B.)

Results of this analysis suggest that adverse noncancer health effects are unlikely to be associated with acute or chronic inhalation exposure to TSDF organic emissions. It should be noted that the health data base for many chemicals was limited, particularly for short-term exposures. The conclusions reached in this preliminary analysis should be considered in the context of the limitations of the health data; the uncertainties associated with the characterization of wastes at the facilities; and the assumptions used in estimating emissions, ambient concentrations, and the potential for human exposure. Additional evaluation of noncancer health effects may be undertaken as part of the third phase of the TSDF regulatory program. To that effect, in the forthcoming proposal preamble for the TSDF air rules for surface impoundments, tanks, and containers, EPA is specifically requesting comments from the public on methodologies and use of health data for assessing the noncancer health effects of TSDF organic emissions. In addition, because there is a potential for cancer and noncancer health effects from TSDF chemicals from indirect pathways, such as ingestion of foods contaminated by air toxics that have deposited in the soil, EPA will evaluate the need to include an indirect pathway element in the TSDF health risk analysis in the future.

The EPA is aware of the uncertainties inherent in predicting the magnitude and nature of toxicant interactions between individual chemicals in chemical mixtures. In the absence of toxicity data on the specific mixtures of concern, and with insufficient quantitative information on the potential interaction among the components (i.e., additivity, synergism, or antagonism), the EPA has assumed additivity to estimate the carcinogenicity of the mixtures of concern. This is consistent with guidance provided in the 1986 EPA "Guidelines for the Health Risk Assessment of Chemical Mixtures" (51 FR 34014).

The EPA also recognizes that there are uncertainties associated with the variability of individual human responses following exposures to toxicants. As stated in the 1986 EPA "Guidelines for Carcinogen Risk Assessment" (51 FR 33992), human populations are variable with respect to genetic constitution, diet, occupational and home environment, activity patterns, and other cultural factors. Because of insufficient data, however, the EPA is unable to determine the potential impact of these factors on the estimates of risk associated with exposure to carcinogens emitted from TSDF.

With regard to ozone, EPA is confident that the organic emissions emitted from WSTF (and from TSDF in general) do contribute to ambient ozone formation. The magnitude of these impacts, however, is difficult to quantify because ozone is a secondary pollutant and is not emitted directly from air pollutant sources. Unlike many other pollutants, ozone results from a series of chemical reactions in the atmosphere between oxidant precursors in the presence of sunlight. Ozone modeling is quite complex, and large uncertainties are associated with the modeling results. Therefore, no attempt was made to estimate the contribution of WSTF/TSDF organic emissions to ambient ozone levels or to quantify the benefits attained through reduction of ozone levels as a result of implementing these standards. However, EPA anticipates that this rule will result in some reduction in ambient ozone levels.

6.5 DISPERSION MODELING

Comment: Commenter AESP-L0016 states that the Industrial Source Complex (ISC) model should be used to predict risks instead of the HEM because the HEM underestimates incidence by a factor of 2 to 3. According to the commenter, it is acceptable to use the HEM instead of the more costly ISC as long as the exposure estimates are adjusted to account for the HEM's underestimation.

Response: The alleged underestimation of exposure estimates to which the commenter refers involved area source modeling of specific model units used to characterize benzene emissions at petroleum and chemical plants. For that particular situation, the exposure estimates generated using the HEM and the ISC did vary by a factor of 2 to 3. That, however, was for a particular set of circumstances unique to those process units and their configuration. To state that HEM will in all cases underestimate exposure (ambient concentration) is unfounded. In fact, it could be argued that the dispersion modeling techniques used in the HEM could overestimate ambient concentrations rather than underestimate them depending on the circumstances. The HEM collocates all sources at a single point, resulting in a potential overestimate of ambient concentrations in the vicinity of this point. In the ISC, sources can be located throughout the facility based on actual plant layouts, thereby allowing the model to account for this separation of sources.

If the ISC were to be used as the model for incidence estimation and the advanced features of this state-of-the-art dispersion model were to be used, it would be necessary to have individual site configurations for each of the facilities modeled. This level of detail is simply not available for all WSTF and TSDF. There were more than 1,400 different facilities modeled using the HEM; facility-specific emissions based on actual throughput data and site-specific meteorology and population data were used in the HEM dispersion modeling.

The HEM has been used successfully in many EPA risk assessments, but it does add an additional element of uncertainty because of the inherent assumptions of the model. The HEM is not a true area source model; as stated above, the model collocates all emission sources at one central point and models the emissions as a point source. The Agency does not think that these shortcomings are serious, however, for estimating nationwide incidence for point or area sources or maximum risk for point sources such as process vents. In fact, this is primarily what the HEM is designed to do.

A more detailed MIR risk assessment was performed using ISCLT for TSDF equipment leaks because more detailed information and data were available in the 1987 National TSDR Survey data base for that specific TSDF. The ISC is unquestionably a more sophisticated dispersion model that is capable of handling complex source and topographic configurations; and where one facility is involved and the data, including source configuration, are available it is the appropriate model to use. Otherwise, there is basically little difference between the two dispersion models and the output they would generate based on similar input data. Appendix B provides more detailed information on the dispersion modeling conducted in the health impacts analysis.

6.6 WORKER EXPOSURE

Comment: Commenter AESP-L0016 believes the risk assessment ignores workers in the facilities, yet the analysis assumes that emissions from control devices will be released near the ground and will expose workers to much higher concentrations than would affect persons living around the facilities.

Response: The EPA agrees that there is the possibility that TSDF workers may be exposed to higher concentrations than those persons in the general public who are living in the vicinity of the facilities. This, however, is not always the case; the area of maximum ambient concentration resulting from an emission source is a function of emission characteristics (e.g., height of release, release temperature, and velocity) as well as the local meteorology (i.e., windspeed, wind direction, and atmospheric stability). In many situations, the location of the maximum ground-level concentration is a considerable distance downwind of the source. Nonetheless, the risk assessment methodology applied in evaluating the impacts of these standards is consistent with EPA's historical approach. Furthermore, other government agencies are charged with the responsibility of protecting and guarding the safety of the workplace.

6.7 LEVEL FOR STANDARDS

Comment: Commenters AESP-00016, AESP-L0003, and AESP-L0006 state that even if the risk estimates were reasonably accurate, then a reduction of 0.87 case of cancer and a cancer incidence of 1 case/yr are insignificant compared to the 800,000 new cancer cases expected to occur nationwide each year. Consequently, the level of protection achieved is negligible.

Response: The revised risk assessment shows that the reduction in cancer incidence resulting from implementation of the standards is greater than was originally expected. In the revised analysis, EPA estimates that for process vents and equipment leaks combined, the cancer incidence reduction could be as high as 1.1 cases/yr, and the probability of contracting cancer to the individual living in the vicinity of the uncontrolled worst-case TSDF could be as high as 5 in 1,000. The EPA does not consider these health risks to be insignificant.

The EPA does recognize that most human activities and events involve some degree of inevitable risk. Either risk may be imposed on the individual (involuntary) or an individual may elect to accept a certain level of risk as a result of certain action, such as cigarette smoking. This latter risk is considered a voluntary imposition of risk. In the case of organics exposure from the TSDF industry, the risk of cancer is imposed on the individual without consent or acceptance. The ambient air concentrations of organics emanating from these facilities increase the individual's probability or odds of getting cancer, and they add to the prevailing cancer incidence. The EPA has determined the public health risk of ambient air exposure to organics emitted from TSDF to be significant. Therefore, the Administrator has decided to take measures to reduce the atmospheric release of organic air pollutants from these sources.

7.0 SELECTION OF STANDARDS

7.1 EMISSION CUTOFF FOR PROCESS VENTS

Comment: Several commenters object to the proposed standard for process vent equipment that requires a fixed 95-percent emission reduction. Commenters AESP-00002, AESP-00006, AESP-L0011, and AESP-00023 believe the requirement would be inequitable because some operations could reduce emissions by 95 percent and still have higher emissions than do some small, uncontrolled operations. Commenter AESP-00016 notes that the standard of a fixed 95-percent reduction in emissions appears to penalize facilities with the lowest emissions and allow those with the highest emissions to meet a less stringent standard (i.e., emission level). Commenter AESP-00023 states that their facility's air emissions are less than 0.45 kg/h (1 lb/h) and are regulated by the State under the CAA. Under the proposed regulation, the commenter's facility would have to install control devices on all condenser and still vents because the standards do not differentiate an acceptable emission level; according to the commenter, this would be inconsistent with CAA regulations. Commenter AESP-L0013 suggests that EPA consider an alternative standard to establish a minimum allowable stack emission rate applicable to all facilities; the commenter suggests 5,000 ppm, which is based on a 95-percent control of a 10-percent organic waste stream. Commenter AESP-00002 also recommends that an emission limit be set.

Response: The EPA agrees with the commenters that the standard for process vents, requiring a fixed 95-percent emission reduction, could result in the control of some small facility operations not necessary to protect the public health. As proposed, all WSTF/TSDF would have to install control devices on all condenser and other process vents regardless of emission levels because the standards did not identify an acceptable emission level. The EPA reanalyzed the process vent air quality and health impacts using updated model unit, emission rate, and facility throughput data. The process vent health impacts were estimated using the Human Exposure Model (HEM) to predict nationwide health effects of exposure to suspected carcinogens in the emissions from WSTF and TSDF.

The HEM is a computer model that calculates exposure levels for a population within 50 km (31 mi) of a facility using 1980 census population distributions and local (National Weather Service) meteorological data. A representative unit risk factor (i.e., 4.5×10^{-6}) was used to quantify the magnitude of risks posed by WSTF process vents at both low and high emission rates. The nationwide annual incidence resulting from WSTF process vent emissions was calculated using the WSTF industry profile (Docket No. F-90-AESF-FFFFF, item S0043) to identify facility locations for population patterns and to determine overall 1985 facility waste solvent throughput for emission estimates. The HEM was run for each WSTF using the site-specific data, and results were summed to get the aggregate risk or total nationwide cancer incidence.

The risk analysis is based on overall facility operations and process vent emissions. It was not possible to determine WSTF unit capacities from the 1986 Screener Survey data. Although total facility waste solvent throughputs were available, the data base did not contain any information on the number of process units at each site; thus, an analysis of individual process units or process vents was not possible. A review of limited site-specific data indicates that, for small quantity recyclers (i.e., <189,000 L or 50,000 gal/yr) that make up most of the industry, the facility would typically consist of one waste solvent recycling unit with process emissions released through one process vent. For large facilities, there may be one, two, three, or more units at the facility that are used to process the total WSTF throughput. No information is currently available to determine specific process unit counts, and no basis is available to assign process unit counts to the facilities nationwide. Therefore, the WSTF model unit emissions, cost, and health risk analyses assume that there is one unit per facility and one process vent per unit as an emission source. This method of facility characterization is not expected to significantly affect the overall analysis. For example, emission estimates are based on total facility waste solvent throughput data; therefore, they reflect overall facility operations, not individual unit throughputs. In the risk analysis, the HEM colocates all sources, and emission characteristics (i.e., stack height and diameter, and exit gas velocity and temperature) are generally similar for all units; as a result, risk estimates are not affected by this method of characterization.

The nationwide maximum individual risk (MIR) was assumed to be the highest individual risk calculated for the actual WSTF analyzed. The MIR is intended to reflect the most exposed individual's chance of getting cancer if exposed continuously for 70 years to the highest annual average ambient concentration resulting from WSTF process vent emissions. Tables 7-1 and 7-2 present a summary of the WSTF process vent risk analysis for the high emission rate case for incidence and MIR using a unit risk factor of 4.5×10^{-6}.

As can be seen in Figures 7-1 and 7-2, the analysis results show that reductions in both MIR and nationwide cancer incidence level off at a facility emission rate of about 2.8 Mg/yr (3.1 ton/yr). Figure 7-3 shows that only minimal emission reductions are achieved by controlling those facilities with total process vent emissions below about 2.8 Mg/yr (3.1 ton/yr). A typical rate of 2,080 h/yr of operation was assumed for the risk analysis; which corresponds to 1.4 kg/h (3 lb/h) of organic emissions. With an emission rate limit of 2.8 Mg/yr (3.1 ton/yr), an incidence reduction of 0.34 case/yr is achieved; lowering the limit does not result in further reductions in incidence. Consequently, the risk analysis results indicate that provision of a facility emission rate limit of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) for process vent emissions provides essentially the same level of protection for public health (in terms of risk and incidence) as does covering process vents at all facilities.

Therefore, the final rule requires control of only those facilities emitting 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) or greater of organic emissions from affected process vents. The EPA has formatted the "small facility cutoff" in terms of both an hourly emission rate (1.4 kg/h [3 lb/h]) and an annual emission rate (2.8 Mg/yr [3.1 ton/yr]). The

TABLE 7-1. SUMMARY OF PROCESS VENT RISK ANALYSIS (INCIDENCE)

Emission rate cutoff, kg/h	Emission rate cutoff, Mg/yr	Percent of facilities below cutoff	Uncontrolled annual incidence, cases/yr	Controlled[a] annual incidence, cases/yr	Total[b] incidence, cases/yr	Incidence reduction, cases/yr
Baseline		NA	0.36	--	0.36	NA
11.8	24.6	86.0	0.12	0.11	0.23	0.13
4.5	9.5	70.4	0.047	0.020	0.067	0.29
2.3	4.7	52.8	0.014	0.020	0.034	0.33
1.4	2.8	45.5	0.007	0.020	0.027	0.33
0.9	1.9	41.9	0.005	0.020	0.025	0.34
0.5	0.9	32.2	0.005	0.020	0.025	0.34
0.3	0.7	27.2	0.002	0.022	0.024	0.34
0.2	0.5	22.3	0.002	0.022	0.024	0.34
0.1	0.3	18.6	0.002	0.022	0.024	0.34
0.05	0.1	9.0	0.002	0.022	0.024	0.34
0	0	0	NA	0.022	0.022	0.34

NA = Not applicable.

[a] Control facility incidence is the residual incidence resulting from process vent emissions to the atmosphere after controls are in place.

[b] Total incidence is the sum of the incidence resulting from uncontrolled facilities plus the incidence from controlled facilities.

TABLE 7-2. SUMMARY OF PROCESS VENT RISK ANALYSIS (MIR)

Emission rate cutoff, kg/h	Emission rate cutoff, Mg/yr	Percent of facilities below cutoff	Maximum concentration, $\mu g/m^3$	Population exposed	MIR
Baseline		NA	176	11	8×10^{-4}
11.8	24.6	86.0	50	2	3×10^{-4}
4.5	9.5	70.4	25	30	1×10^{-4}
2.3	4.7	52.8	10	1	6×10^{-5}
1.4	2.8	45.5	7[a]	11	4×10^{-5}
0.9	1.9	41.9	7	11	4×10^{-5}
0.5	0.9	32.2	7	11	4×10^{-5}
0.3	0.7	27.2	7	11	4×10^{-5}
0.2	0.5	22.3	7	11	4×10^{-5}
0.1	0.3	18.6	7	11	4×10^{-5}
0.05	0.1	9.0	7	11	4×10^{-5}
0	0	0	7	11	4×10^{-5}

NA = Not applicable.
MIR = Maximum individual risk.

[a] This concentration occurs at a facility that has been controlled to the 95% level.

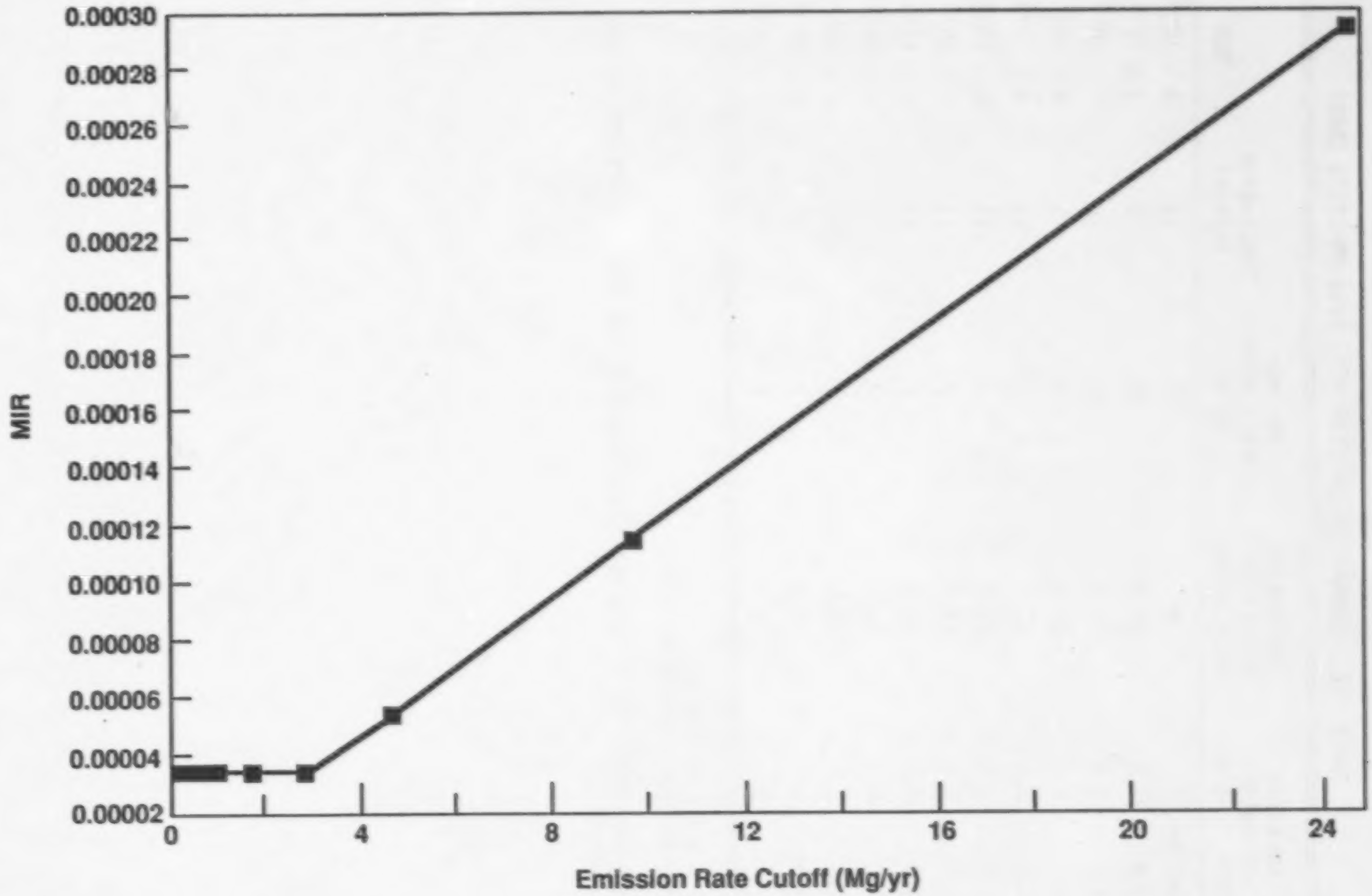

Figure 7-1. Emission rate cutoff vs. maximum individual risk (high emissions).

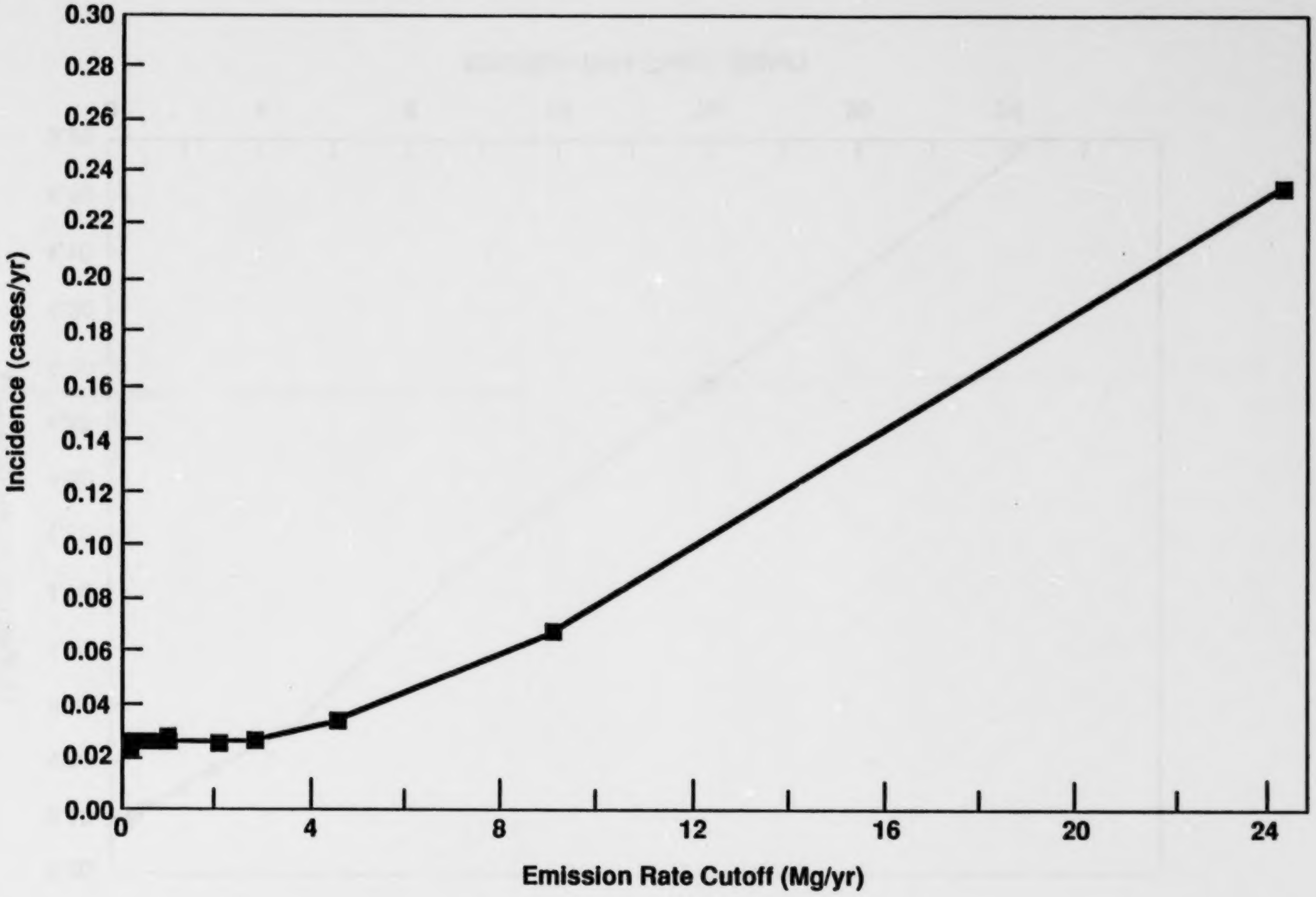

Figure 7-2. Emission rate cutoff vs. incidence (high emissions).

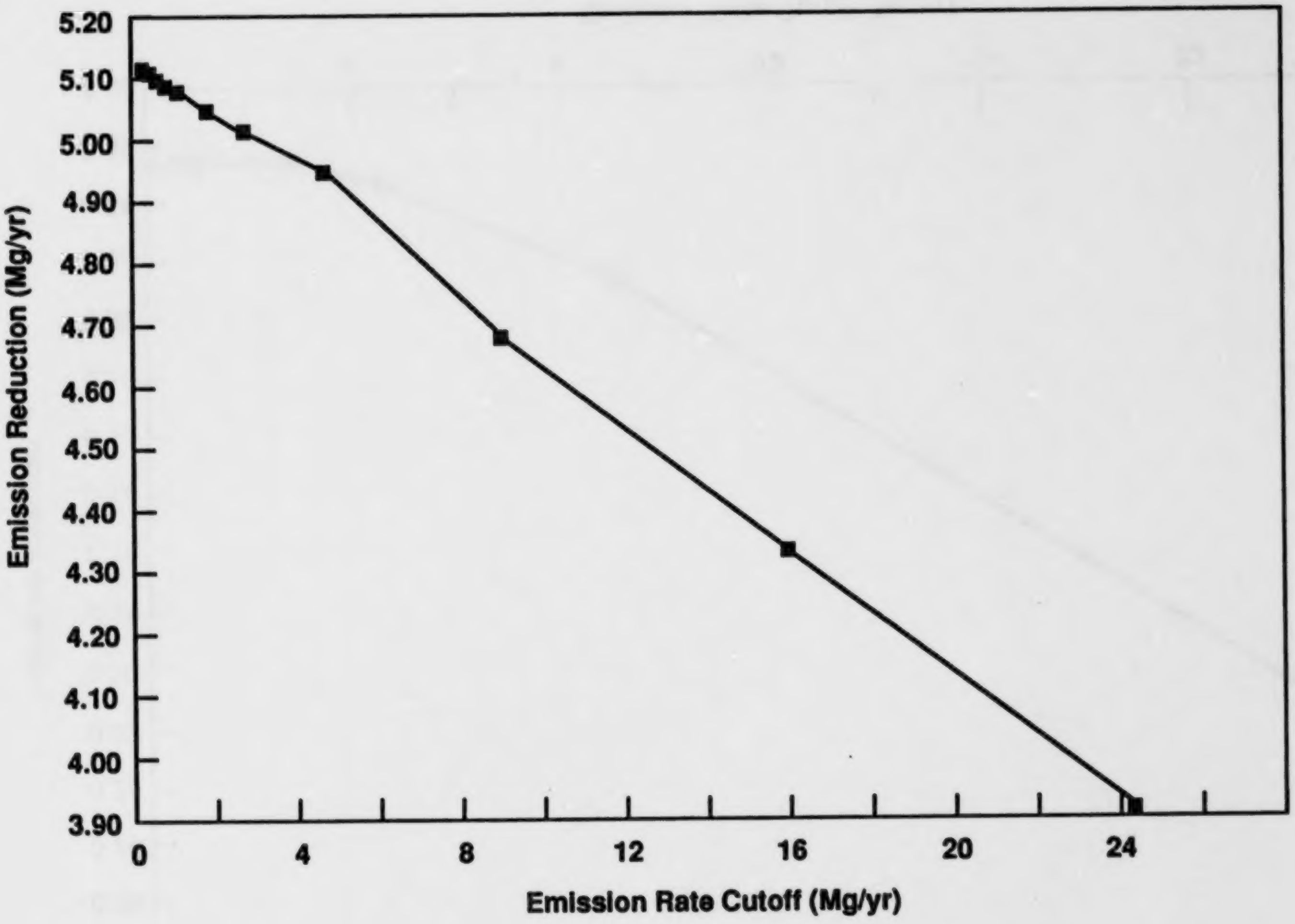

Figure 7-3. Emission rate cutoff vs. emission reduction.

overall risk analysis was based on annual throughput, emission, and ambient air concentration values; therefore, the annual limit was selected. However, to avoid potential short-term, acute air pollution situations, the corresponding hourly emission limitation was included, reflecting the number of annual operating hours.

A total TSDF/WSTF facility emission rate limit also provides the owner/operator with a degree of flexibility to control sources in a more cost-effective manner than is allowed without the limit format on a facility basis.

Because the promulgated standards contain the facility-based emission rate limit that is more effective in controlling emissions from affected sources and excluding facilities with little emission reduction potential, the 10-percent concentration criterion for process vents has not been included in the final rules. Based on the post-proposal emissions and health risk analyses, this emission rate limit represents an emission level from process vents that is protective of human health and the environment, and below which additional meaningful reductions in nationwide health risk and environmental impacts attributable to process vents cannot be achieved. Control of facilities with process vent emissions less than the emission rate limit does not result in further reductions of either cancer risk or incidence on a nationwide basis. Facilities with organic emissions from process vents that do not exceed these emission rates will not have to install controls on affected process vents.

Because the emission rate limits (3 lb/h and 3.1 ton/yr) provide reasonable health-based cutoffs, EPA considered dropping completely the organic content criterion (i.e., at least 10 percent total organics). However, EPA decided not to completely eliminate the organic content criterion because it is not clear that the same controls can be applied to very-low-concentration streams as can be applied to the higher-concentration streams that generally are associated with emission rates greater than the limits. For low-concentration streams, EPA questions whether controls are needed on a national or generic basis, but is unable to resolve this question at this time. Thus, EPA decided to defer controlling very-low-concentration streams until it is able to better characterize and assess these streams and the appropriate controls.

Once EPA decided to consider facilities that manage very-low-concentration organic wastes as a separate category, there remained the problem of determining the appropriate criterion. The EPA examined existing data on air strippers (see Table 4-1, Chapter 4.0); it appeared that the quantity of emissions and the risk associated with air strippers treating streams with concentrations below 10 ppmw may be relatively small, thus minimizing the potential harm of deferring control until a later time. Examples of facilities managing low-concentration wastes are sites where ground water is undergoing remedial action under CERCLA or corrective action pursuant to RCRA. Given the limited set of precise data available, and the comments that the 10-percent criterion was too high, EPA determined that an appropriate criterion would be 10 parts per million (ppm) total organics in the waste by weight.

The 10 ppmw is not an exemption from regulation; it is intended only as a way for EPA to divide the air regulations into phases. The EPA is deferring action on very-low-concentration streams (i.e., ones with less than 10 ppmw total organic content) from the final rule today but will evaluate and announce a decision later on whether to regulate these waste streams.

7.2 FEASIBILITY OF A 95-PERCENT CONTROL

Comment: Whereas Commenters AESP-L0003 and AESP-00007 support the 95-percent level of control for process vents, Commenters AESP-L0011, AESP-00002, AESP-L0025, and AESP-00006 state that the proposed regulation does not consider the limits of the best available technology. A 95-percent reduction may not be technologically achievable for a liquid waste stream emitting vapors with a low organic content with currently available pollution control equipment. Commenter AESP-00025 does not believe the level is feasible given baseline requirements under CAA State regulations.

Response: Emission control technologies applicable to WSTF process vent emissions (those emissions released to the atmosphere through process vents such as the primary condenser exhaust) include secondary condensers, carbon adsorbers, flares, thermal afterburners, incinerators, and scrubbers. The emission reduction potentially achievable by each control technology depends on the physical parameters associated with the process vent stream and the design and operation of the control device. For example, the efficiency of a condenser is dependent on the physical/chemical properties of the solvents being condensed, the organic concentration in the gas stream, and the operating temperature of the condenser.

Review of the available information on WSTF operations indicates that condensers, carbon adsorbers, incinerators, and scrubbers are widely used; however, condensers and carbon adsorbers appear to be the technology of choice to reduce process emissions of organics at WSTF. Properly designed, operated, and maintained, each of these control technologies can achieve a 95-percent emission reduction, although there are situations in which each particular technology may not be applicable as a control method for WSTF process vents. For example, secondary condensers used for emission control (or supplemental product recovery) are not well-suited for vent streams containing organics with low boiling points, high moisture content, large quantities of inerts (e.g., CO_2 or N_2), or low concentrations of organics (i.e., too low thermodynamically to support a liquid phase). Conditions for which carbon adsorption is not ideally suited for WSTF vents, primarily because of cost considerations, include streams with high organic concentrations, very high or low molecular weight compounds, high moisture content, and mixtures of high- and low-boiling-point organics. Nonetheless, based on an analysis of these two control technologies (condensation and carbon adsorption), at least one should be technically applicable to each affected WSTF process vent stream and should be capable of achieving the 95-percent control efficiency for removal of organic emissions that is the basis of the standard.

With the establishment of a facility emission rate limit, it is expected that condensers will remain the technology of choice for control of process vent emissions because many of the low-concentration streams likely will not require control to meet the 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) facility process vent organic emission limit.

Because the final rules could apply to dilute process vent streams and the rule is formatted in terms of a weight-percent reduction standard, it is necessary to include a volume concentration standard in the final rule to account for the technological limitations of enclosed combustion devices, one of the control technologies examined as part of the rulemaking, used for treating dilute streams. Below a critical concentration level, the maximum achievable efficiency for enclosed combustion devices decreases as inlet concentration decreases; thus, for streams with low organic vapor concentrations, the 95-percent mass reduction may not be technologically achievable in all cases. Available data show that 20 ppmv is the lowest outlet concentration of total organic compounds achievable with control device inlet streams below approximately 2,000 ppmv total organics (48 FR 48932, October 21, 1983; and 48 FR 57538, December 30, 1983). Therefore, a concentration limit of 20 ppmv has been added as an alternative control device standard for incinerators, boilers, and process heaters to allow for the drop in achievable destruction efficiency with decreasing inlet organics concentration. For consistency, the 20 ppmv is expressed as the sum of the actual individual compounds, not carbon equivalents, on a dry basis corrected to 3 percent oxygen. For facilities that do not meet the emission rate limit, the final process vent standards require that control devices achieve a 95-percent reduction in total organic emissions for the facility or, in the case of enclosed combustion devices, a reduction of each process vent stream to a concentration of 20 ppmv total organic compounds.

7.3 FEASIBILITY OF CONDENSERS

Comment: Several commenters do not agree that condensers provide a feasible means of meeting the 95-percent emission reduction requirement. Commenter AESP-L0007 believes that condensers could not achieve a 95-percent efficiency without cooling, and cooling would freeze the water in the waste stream in the TSD portion of the facility. In comparison, Commenter AESP-L0007 suggests that the 95-percent efficiency be reduced to 85 percent so that a brine-cooled vent condenser could be used. Commenters AESP-00035, AESP-L0009, AESP-00010, AESP-00024, AESP-L0025, and AESP-00018 do not believe EPA has justified applying the same control to the wide variety of waste solvents, and that, in many cases, condensers are not technically feasible due to the nature of the constituents. Commenter AESP-L0016 objects to the estimate of condenser efficiency applied in the analysis. According to the commenter, about six times more condenser area is needed to achieve the required control efficiency for the higher flow rates of about 18 kg/h (40 lb/h) assumed in the proposed standard. Larger condensers could also be used effectively and economically to reduce emission levels by more than 95 percent. This commenter also questions the selection of CFC-12 as a condenser refrigerant in the calculations because the temperature difference between condensing vapors and coolant is an important factor governing control efficiency. The commenter suggests use of CFC-22 or R-50 or others with lower boiling points that will lead to a higher reduction efficiency.

Response: The EPA examined the feasibility of using condensers for organic emission control using a state-of-the-art chemical engineering computerized process simulator known as the Advanced System for Process Engineering (ASPEN). A variety of chemical constituents and operating conditions was examined to determine the organic removal efficiency achievable through condensation. The ASPEN condenser configuration consisted of (1) a floating-head, one-pass, shell-and-tube heat exchanger, (2) a refrigeration unit capable of producing a coolant (e.g., chilled brine) at a temperature as low as -28 °C (-20 °F), and (3) an optional primary water-cooled heat exchanger. This final item is considered necessary in some instances to reduce the size of the refrigeration unit and to remove water vapor in order to avoid freezing problems because the condenser temperature is low enough to cause ice buildup on heat transfer surfaces.

The constituents selected for the condenser analysis (toluene; MEK; 1,1,1 trichloroethane; and methylene chloride) are considered to be representative of the solvents recycled by the WSTF industry; selection was a subjective judgment based on a review of relevant information and literature, which included an NASR survey as well as numerous site-specific plant trip reports and responses to EPA Section 3007 information requests. Three of these four solvents are the same as were used in the proposal analysis. Methylene chloride, a commonly recycled solvent, was added to the list of solvents for analysis in order to provide a comprehensive range of volatilities for the condenser analysis. Methylene chloride is at the lower end of the boiling point range and is therefore more difficult to condense. Methylene chloride (a relatively low-boiling/high-volatility compound) has a boiling point of 40 °C (104 °F); this compares with boiling points of

110 °C, 79 °C, and 74 °C (230 °F, 174 °F, and 165 °F) for toluene, MEK, and trichloroethane, respectively.

Ten organic emission rates were analyzed for each of the four solvent types; emission rates varied from 0.04 kg/h (0.08 lb/h) up to 4.8 kg/h (10.60 lb/h). Three exhaust gas flow rates (3.9, 0.6, and 0.3 L/s [8.3, 1.2, and 0.6 scfm]) were examined with the 10 emission rates to provide a wide range of organic concentrations, from 1 to 60 percent organics. Emission streams were assumed to consist of organics and a noncondensible gas (e.g., air). Thus, a total of 40 emission stream cases were included in the condenser analysis in order to represent the wide range of stream conditions encountered in the industry.

The results of the ASPEN condenser simulation (Docket No. F-90-AESF-FFFFF, item S0023) indicate that in only 15 of the 40 cases examined was a removal efficiency of 95 percent achieved. In 7 of the 40 cases, ASPEN shows that, for those particular situations, appreciable condensation would not occur. This results from the partial pressure of the organic constituent in the vapor phase being too low to thermodynamically support a liquid phase. Six of the seven cases that would not condense involved methylene chloride at concentrations of about 10 percent or less (by weight). The seventh case was a low concentration (1 percent) MEK.

In general, the WSTF condenser analysis indicates that condensers cannot universally achieve a 95-percent emission reduction when applied to WSTF process vents. However, they do provide, where applicable, an effective, economical method of emission reduction. It must also be pointed out that EPA did not base the facility process vent emission reduction requirements solely on the use of condensers. Any technology capable of meeting the standards is acceptable. The 95-percent control efficiency option for WSTF/TSDF process vents was analyzed on the basis of applying a condenser to the vent as the initial choice of control technology; for those cases where condensation is not feasible, carbon adsorption can be used, for example. Carbon adsorption is considered capable of attaining a 95-percent control efficiency for organics removal on all WSTF process vent streams.

With regard to the comment that increased condenser area or an alternative condenser coolant will lead to a higher emission reduction or control efficiency, the condenser analysis shows that there are technical limits on the efficiency of condensers that go beyond condenser area and operating parameters. The efficiency of vent condensers is dependent on the physical properties of the solvents being condensed and the solvent concentration in the gas stream as well as the operating temperature and surface area of the condenser. The analysis conducted by EPA has shown that low solvent concentration and the high volatility of some solvents typically recycled at WSTF are more limiting to condenser efficiency than is operating temperature. The emission rate limit will reduce the requirement for control of some low-concentration streams; however, solvent volatility will remain a limiting factor in condenser efficiency.

7.4 FEASIBILITY OF FLARES

Comment: Eight commenters object to the use of flares at recycling facilities because of technical and safety concerns (AESP-00016, AESP-00019, AESP-00009, AESP-L0007, AESP-00005, AESP-L0001, AESP-L0018, and AESP-L0025). Commenters AESP-L0007, AESP-00022, and AESP-L0005 state that flares generally require a constant emission source for efficient operation and are not suitable on intermittent sources or low-level emissions typical of recycling operations. Commenter AESP-L0001 describes flare pilot thermocouples as "not reliable" and states that they usually last only 3 years as flare pilot flame detectors. This commenter recommends that EPA recognize that visual inspection and inherent reliability of the fuel supply should suffice for pilot flame detection methods. Commenters AESP-00016, AESP-00019, and AESP-00009 state that flares present the danger of explosion, especially if they malfunction, and according to Commenter AESP-00016, many State laws prohibit the use of flares at recycling facilities.

Response: Available information on WSTF operations indicates that condensers, carbon adsorbers, and incinerators are the most widely used control technologies; therefore, they are expected to be the technologies of choice to reduce process organic emissions at WSTF. The final technical analyses have shown that a 95-percent control efficiency can be achieved with secondary condensers for many WSTF process vents or with carbon adsorbers in cases where secondary condensers are not feasible. Flares are not required controls but are an available option for facilities so equipped, provided that they meet the criteria in the promulgated standards.

With regard to the safety of flares, the Agency has determined that the use of flares to combust organic emissions from TSDF process vents would not create safety problems if engineering precautions are taken in the design and operation of the system. The following are typical engineering precautions. First, the flare should not be located in such close proximity to a process unit being vented that ignition of vapors is a threat to safety. In the analysis conducted for this standard at proposal, it was assumed that the flare would be located as far as 122 m (400 ft) from the process unit. Second, controls such as a fluid seal or flame arrestor are available that would prevent flashback. These controls were considered in EPA's cost analysis for the proposed rule (EPA-450/3-86-009). Finally, the use of a purge gas, such as nitrogen, plant fuel gas, or natural gas, and/or the careful control of total volumetric flow to the flare would prevent flashback in the flare stack caused by low off-gas flow.

7.5 FEASIBILITY OF CARBON ADSORBERS

Comment: Several commenters object to the identification of carbon adsorption as a control technique because of technical and safety concerns. Commenters AESP-L0007 and AESP-00022 claim that devices are needed for each vent due to the low, intermittent emissions (which increase the costs), and that the devices are not efficient for low concentration operations. These devices also are emission sources themselves because the used carbon must be regenerated or buried, thus producing more emissions and increasing costs. According to Commenter AESP-00019, carbon adsorbers also are generally inappropriate because most WSTF use thin-film evaporators for recycling multicomponent solvent streams and only very few use fractional distillation columns to separate out single solvents. According to Commenters AESP-00019, AESP-00016, and AESP-00009, use of carbon adsorbers at facilities handling multicomponent solvent waste streams also increases the likelihood of hot spots resulting in fire or explosion because this control is not compatible with all solvents. Commenter AESP-L0016 objects because

EPA did not provide support for the removal efficiency of carbon adsorbers and cites other authorities that support a 98-percent removal efficiency for this type of control device.

Response: First, it should be noted that carbon adsorption is one of several control technologies that could be used to attain the standards. Other technologies include condensers, flares, incinerators, boilers, and process heaters. The commenters are correct in asserting that carbon adsorption devices are potential emission sources because of the regeneration or disposal of spent carbon. However, the emissions from these sources should be minimal compared to the emissions from uncontrolled process vents if proper procedures are followed in managing the regeneration and disposal of spent carbon. The costs of regeneration and disposal are not unreasonable and are included in the carbon adsorption control cost analysis.

Regarding carbon adsorption applications, EPA acknowledges that safety is an important consideration, but concludes that any safety and technical problems can be avoided through proper design, operation, and maintenance, including sorbent selection. The problem of hot spots is associated with multicomponent systems, especially large beds (large diameter) with low flow rates, for cases involving low concentrations as well as saturated (high) concentrations. The problem results from a failure of the bed to adequately dissipate the heat generated through release of heat of the adsorption. Physical adsorption is an exothermic operation that is most efficient within a narrow range of temperature and pressure. Excessive heat buildup can result in problems. It has been found that some carbon types are worse than others in regard to heat generation. For example, coal-based carbons have fewer problems than do wood-based carbons. This is in part due to the temperature profiles generated in the carbon manufacturing stage; coal-based carbons are exposed to higher temperatures at the tail end of the process, whereas wood-based carbons are exposed to the higher temperatures in the middle of the manufacturing process. Another contributing factor is bed size; i.e., larger diameters result in poor heat transfer. It is difficult to predict what particular solvents (or organics) would generate excess heat when adsorbed by a particular sorbent; solvent/sorbent testing would likely be required.

With regard to carbon-bed efficiencies, multicomponent solvent vapor streams can experience reduced efficiencies for particular components. This is typically a result of higher molecular weight compounds displacing the lighter molecular weight compounds as the various compounds compete for adsorption locations. The lighter compounds move down the bed as they are displaced; this causes a "wave front" for each of the compounds and can result in early breakthrough. In some cases, lighter components can exit the bed at a higher concentration than the entering concentration. This is of concern in dealing with solvents because lower explosive limit (LEL) values may be exceeded.

Multicomponent systems generally present a much more complex design problem than do single component systems. With a wide mix of solvents in a multicomponent stream, selection of proper sorbents would typically require design simulations to evaluate the possible combinations and alternatives. A change in the component mix would effectively alter the operating (and design) situation; breakthrough could occur earlier if less adsorbable components are present. Another consideration in dealing with multicomponent gas streams is component interaction. This may include cases where components are mutually soluble or reactive with carbon; loss of bed capacity (or efficiency) through fouling is a common consequence. Component interactions are difficult to predict. Fouling also occurs when monomers present in the stream are polymerized as a result of elevated temperatures or other factors. This is a particularly critical problem when beds are designed for regeneration.

Moisture also reduces the capacity of the carbon. Adsorbents, especially oxygenated adsorbents, have a strong preferential affinity for water vapor over organic gases and would have difficulty attaining high organic removal efficiencies for the high moisture gas streams (i.e., relative humidities greater than 50 percent) from some WSTF and TSDF distillation vents. If there is a swing in moisture levels that is outside the design, then early breakthrough can occur.

The performance of carbon adsorption systems is improved by reducing the relative humidity of the controlled gas stream to 50 percent or less.

If the gas stream is below 21 °C (70 °F) at a 100-percent relative humidity, a reduction of the relative humidity can be achieved by heating the gas stream to approximately 32 °C (90 °F). If the gas stream is above 21 °C (70 °F) at a 100-percent relative humidity, the gas stream can first be cooled to condense the water, then be reheated to achieve a relative humidity of 50 percent or less. These conditions can be obtained by using only a duct heater, or by using both a condenser and a duct heater. The most effective means of avoiding the complication of multicomponent early breakthrough is proper design followed by close monitoring of the bed effluent; this allows carbon regeneration or replacement to occur as needed. The final rulemaking requires monitoring of carbon beds for breakthrough as part of the standard's implementation procedures.

In response to comments, EPA examined carbon adsorption design, operation, and performance data from a number of plants in a wide variety of industries; and EPA has reexamined, with the help of carbon manufacturers and custom carbon adsorption equipment designers, the elements that affect carbon adsorption efficiency. This analysis[1] has reinforced the Agency's original conclusion that a well-designed, operated, and maintained adsorption system can achieve a 95-percent control efficiency for all organics under a wide variety of stream conditions over both short-term and long-term averaging periods. The major factors affecting performance of an adsorption unit are temperature, humidity, organics concentration, volumetric flow rate, "channelling" (nonuniform flow through the carbon bed), regeneration practices, and changes in the relative concentrations of the organics admitted to the adsorption system. The WSTF/TSDF process vent stream characteristics are typically well within design limits in terms of gas temperatures, pressure, and velocity for carbon adsorbers. For example, the adsorption rate in the bed decreases sharply when gas temperatures are above 38 °C (100 °F). A review of plant field data shows that these high-temperature streams are generally not found on WSTF/TSDF process vents. If high-temperature gas streams are encountered, the gas stream can be cooled prior to entering the carbon bed. Also, gas velocity entering the carbon bed should be quite low to allow time for adsorption to take place; the WSTF/TSDF stream flows are very low and, as a result, bed depth should not be excessive. For cases where the organic concentration in the gas stream exceeds the optimum range for use in carbon adsorption, the gas stream can be diluted using nitrogen to achieve the desired organic concentration (e.g., 25 percent of the LEL).

In summary, EPA has concluded that, for WSTF/TSDF process vent streams, carbon adsorption can reasonably be expected to achieve a 95-percent control efficiency provided (1) the adsorber is supplied with an adequate quantity of high-quality activated carbon, (2) the gas stream receives appropriate conditioning (e.g., cooling, filtering) before entering the carbon bed, and (3) the carbon beds are regenerated or replaced before breakthrough. The EPA does not support a higher control efficiency (i.e., 98 percent as opposed to 95 percent) for carbon adsorption units applied to WSTF/TSDF process vents, particularly in light of the design considerations related to controlling multicomponent vent streams when the organic mix is subject to frequent change.

With regard to commenters' concerns that carbon adsorbers are emission sources themselves, EPA agrees that there would be no environmental benefit in removing organics from an exhaust gas stream using adsorption onto activated carbon if the organics were subsequently released to the atmosphere during desorption or during carbon disposal. The Agency therefore expects owners or operators of TSDF using carbon adsorption systems to control organic emissions to take steps to ensure that proper emission control of regenerated or disposed carbon occurs. For onsite regenerable carbon adsorption systems, the owner or operator must account for the emission control of the desorption and/or disposal process in the control efficiency determination. In the case of offsite regeneration or disposal, the owner or operator should supply a certification, to be placed in the operating record of the TSDF, that all carbon removed from a carbon adsorption system used to comply with Subparts AA and BB is either: (1) regenerated or reactivated by a process that prevents the release of organics to the atmosphere (NOTE: EPA interprets "prevents" as used in this paragraph to include the application of effective control devices such as those required by these rules), (2) incinerated in a device that meets the performance standards of Subpart O, or (3) disposed in compliance with Federal and State regulations.

7.6 FEASIBILITY OF LEAK DETECTION AND REPAIR (LDAR) PROGRAM

Comment: Commenter AESP-L0018 supports the LDAR program as proposed; however, Commenter AESP-L0016 opposes the fugitive standards because they fail to require the proper technology to control releases from pumps and valves. The commenter states that EPA should set standards that require a 100-percent control, based on what available control (e.g., sealed bellows valves, sealless pumps, or dual mechanical seals for pumps) can achieve. The commenter believes that the degree of control represented by sealed bellows valves should be required unless the owner or operator shows that, for wastes treated at a particular facility, unacceptable rapid corrosion would ensue or the controls are not suitable in the particular setting. The commenter believes that superior emission controls cannot be rejected under RCRA solely because they are more costly than less effective controls.

Response: Control technologies for fugitive emissions from equipment leaks, as required by the proposed standards, comprise the use of control equipment, inspection of process equipment, and repair programs to limit or reduce emissions from leaking equipment that handle streams with total organic concentrations of at least 10 percent by weight. These control technologies have been studied and evaluated extensively by EPA for equipment containing fluids with 10 percent or more organics and are similar to those required by national emission standards for chemical, petrochemical, and refining facilities under the CAA.

A monthly LDAR program would have been required by the proposed standards for WSTF/TSDF pumps and valves. Based on results of the EPA's LDAR model, once a monthly monitoring plan is in place, emission reductions of 73 percent and 59 percent can be expected for valves in gas and light liquid service, respectively, and a 61-percent reduction in emissions can be achieved for pumps in light liquid service. For compressors, the use of mechanical seals with barrier fluid systems and control of degassing vents (95 percent) are required, although compressors are not expected to be commonly used at WSTF/TSDF. The use of control equipment (rupture disc systems or closed vent systems to flares or incinerators) is the technical basis for control of pressure relief devices. Closed purge sampling is the required control for sampling connection systems and is the most stringent feasible control. For open-ended valves or lines, the use of caps, plugs, or any other equipment that will close the open end is required; these are the most stringent controls possible. Flanges and pressure relief devices in liquid service are excluded from the routine LDAR requirements, but must be monitored if leaks are indicated. For operations such as those expected at WSTF/TSDF, total reductions in fugitive emissions from equipment leaks of almost 75 percent are estimated for the entire program.

The EPA agrees with the commenter that the level of control required by the LDAR program does not result in the highest level of control that could be achieved for fugitive emissions from pumps and valves in certain applications. In some cases, there are more stringent, technologically feasible controls. For example, leakless equipment for valves, such as diaphragm and sealed bellows valves, when usable, eliminates the seals that allow fugitive emissions; thus, control efficiencies in such cases are virtually 100 percent as long as the valve does not fail. In appropriate circumstances, pumps can be controlled by dual mechanical seals that would capture nearly all fugitive emissions. An overall control efficiency of 95 percent could be achieved based on venting of the degassing reservoir to a control device.

With regard to leakless valves, the applicability of these types of valves is limited for TSDF, as noted by EPA in the proposal preamble. The design problems associated with diaphragm valves are the temperature and pressure limitations of the elastomer used for the diaphragm. It has been found that both temperature extremes and process liquids tend to damage or destroy the diaphragm in the valve. Also, operating pressure constraints will limit the application of diaphragm valves to low-pressure operations such as pumping and product storage facilities.

There are two main disadvantages to sealed bellows valves. First, they are, for the most part, only available commercially in configurations that are used for on/off valves rather than for flow control. As a result, they cannot be used in all situations. Second, the main concern associated with this type of valve is the uncertainty of the life of the bellows seal. The metal bellows are subject to corrosion and fatigue under severe operating conditions.

Over 150 types of industries are included in the TSDF community, and EPA does not believe that leakless valves can be used in an environmentally sound manner on the wide variety of operating conditions and chemical constituents found nationwide in TSDF waste streams, many of which are highly corrosive. Corrosivity is influenced by temperature and such factors as the concentration of corrosive constituents and the presence of inhibiting or accelerating agents. Corrosion rates can be difficult to predict accurately; underestimating corrosion can lead to premature and catastrophic failures. Even small amounts (trace quantities) of corrosives in the stream can cause corrosion problems for sealed bellows valves; these tend to aggressively attack the metal bellows at crevices and cracks (including welds) to promote rapid corrosion. Sealed bellows valves particularly are subject to corrosion because the bellows is an extremely thin metallic membrane.

At proposal, it was estimated that 20 percent of all plants process halogenated compounds that tend to be highly corrosive. The subsequently obtained 1986 Screener Survey data show that, of the TSDF indicating solvent recovery operations, at least 33 percent of the total handle halogenated organics. Furthermore, of the 12 major chemicals determined from site-specific data to be commonly occurring in WSTF waste streams, all of the chemicals determined to be carcinogenic are halogenated (methylene chloride, chloroform, and carbon tetrachloride). Similarly, of the 52 constituents in TSDF waste streams contributing to the emission-weighted unit risk factor, about 50 percent are halogenated and account for the vast majority of the estimated nationwide emissions of carcinogens. Thus, TSDF are known to routinely handle and treat chemicals that may destroy sealed bellows and diaphragm valves.

The durability of metal bellows is highly questionable if the valve is operated frequently; diaphragm and bellows valves are not recommended for general service. EPA does not believe that the application of sealed bellows and diaphragm valves is technologically feasible for all TSDF valve conditions or that their application would lead to a significant reduction in emissions and health risks. Valve sizes, configurations, operating temperatures and pressures, and service requirements are some of the areas in which diaphragm, pinch, and sealed bellows valves have limitations that restrict service. With regard to the emission reductions achieved by sealed bellows, diaphragm, and pinch valve technologies, these valves are not totally leakless. The technologies do eliminate the conventional seals that allow leaks from around the valve stem; however, these valves do fail in service from a variety of causes and when failure occurs, these valves can have significant leakage. This is because these valves generally are not backed up with conventional stem seals or packing. The EPA currently is reevaluating the control efficiencies assigned to these technologies. Because these leakless types of equipment are limited in their applicability and in their potential for reducing health risks, EPA did not consider their use as an applicable control alternative for nationwide TSDF standards. The EPA has requested, in a separate FEDERAL REGISTER notice (54 FR 30228, July 19, 1989), additional information on the applicability and use of leakless valves at TSDF.

For pumps, the most effective controls that are technologically feasible (dual seals) in some cases also were not selected as the basis for equipment-leak standards. The impact analysis indicates that including LDAR results in less emission and risk reduction than does including equipment requirements for pumps. However, the difference in the emission and health risk reductions attributable to implementing a monthly LDAR program rather than the more stringent equipment standards for pumps appears to be small in comparison to the results of the overall standards (about 5 percent). The overall standards, including a LDAR program for pumps and valves, would achieve an expected emission reduction for TSDF equipment leaks of about 19,000 Mg/yr (21,000 ton/yr). The estimated MIR from equipment leak emissions would be reduced to 1×10^{-3} from 5×10^{-3} based on the TSDF equipment leak emission-weighted unit risk factor; cancer incidence would be reduced to 0.32 case/yr from 1.1 cases/yr. In comparison, including dual seals for pumps could achieve an additional fugitive emission reduction of about 1,200 Mg/yr (1,320 tons/yr) and an additional incidence reduction of about 0.06 case/yr. The MIR, with leakless controls for pumps, would be unchanged at 1×10^{-3}.

Given the small magnitude and the imprecise nature of the estimated emission and risk reductions associated with including dual seals for pumps in the overall standard, EPA considers the two control alternatives (i.e., LDAR and dual seals) as providing the same level of protection. The data and models on which the risk estimates are based are not precise enough to quantify risk meaningfully to a more exact level. The data and models include uncertainties from the emission estimates, the air dispersion modeling, and the risk assessment, which involves unit risk factor, facility location, population, and meteorologic uncertainties.

The EPA considered these factors when deciding whether to require TSDF to install dual seals on pumps to control air emissions rather than to rely on monthly LDAR. Considering the limited applicability of additional equipment controls and the low potential for additional reductions in health risks of applying equipment controls for valves at TSDF and the estimated emissions and risk reductions if leakless equipment for pumps were required, EPA is not requiring leakless equipment at this time.

In Phase III (the multiphased approach to TSDF emission standards development is described in response to comment 3.2.2), EPA will further examine the feasibility and impacts of applying additional control technology beyond the level required by today's standards. For example, dual mechanical seals may be an appropriate emission control method when applied selectively to wastes with high concentrations of toxic chemicals. In such applications, the reduction in toxic emissions (and consequently the reduction in residual risk) may be significant for select situations.

7.7 FEASIBILITY OF USING CONTROLS IN SERIES

Comment: Commenter AESP-L0016 states that EPA should evaluate carbon adsorption in series with a condenser because condensers work best with concentrated streams and carbon units work best with low-concentration streams. The two systems together could yield an overall efficiency of 99 percent even if each unit were only 90 percent effective.

Response: The EPA did evaluate the feasibility of using a carbon adsorption device in series with a condenser to control WSTF/TSDF process vent emissions. The objective of the analysis was to determine whether the combination of control devices would yield an overall control efficiency greater than the 95 percent that is achievable through use of a single device. If, for example, a 99-percent overall control efficiency is desired and it is assumed that the carbon adsorption system is capable of achieving a 95-percent control efficiency in all cases (a reasonable assumption for a properly designed, operated, and maintained system), then a minimum efficiency of 80 percent would be required for the condenser in series with the carbon bed. However, the EPA condenser analysis conducted for the WSTF model units shows that an 80-percent control was not achieved in 16 of the 40 cases examined. In 7 of the 40 cases, the analysis showed that no appreciable condensation would occur, because the partial pressure of the organic in the vapor phase (a function of concentration) would be too low to thermodynamically support a liquid phase. Because the model unit cases used in the analysis are considered representative of the wide range of current WSTF operations, EPA does not believe that condensers are capable of achieving the required minimum control efficiency in all cases. Therefore, the use of carbon adsorption and condensation in series to achieve a 99-percent control is not considered technically feasible on an industrywide basis and was not selected as the basis for the standard.

In addition to the question of technical applicability (see Section 7.4, Feasibility of Flares), EPA reviewed the health and environmental impacts of secondary condensers/carbon adsorbers (reflecting a 95-percent control) compared to flares and incinerators (reflecting a 98-percent control) as further information in deciding whether to require a 98-percent control level. Application of flares or incinerators for WSTF process vent emissions would be expected to reduce nationwide emissions from about 8,100 Mg/yr (8,900 tons/yr) to about 890 Mg/yr (980 tons/yr). Condensers and carbon adsorbers would reduce the emissions to about 900 Mg/yr (990 tons/yr). Thus, an incremental emission reduction of about 10 Mg/yr (11 tons/yr) results with flares and incinerators (with the emission rate cutoff in place). The EPA's estimates that include flares or incinerators in the overall proposed standard would reduce annual cancer incidence attributable to process vents from 0.38 case/yr to about 0.02 case/yr in comparison to 0.03 case/yr for including condensers in the overall proposed standard. The estimated MIR associated with WSTF emissions would be reduced from about 8 x 10^{-4} to about 2 x 10^{-5} with flares or incinerators and 4 x 10^{-5} with condensers or carbon adsorbers. Therefore, based on available information and data, a 95-percent control appears to provide essentially the same level of protection for public health as does a 98-percent control and is achievable by all WSTF processes. For these reasons, EPA selected the 95-percent control over a 98-percent control as the basis of the standard for WSTF process vent emissions.

7.8 REFERENCE

1. U.S. Environmental Protection Agency. Carbon Adsorption for Control of VOC Emissions: Theory and Full Scale System Performance. Office of Air Quality Planning and Standards. Research Triangle Park, NC. June 6, 1988.

8.0 COST IMPACTS

8.1 CARBON ADSORBER COST ESTIMATES

Comment: Commenter AESP-00016 questions the cost estimates for carbon absorbers; at his facility, a carbon absorption unit costs about $25,000 and has operational costs that average $12,000/yr. Other commenters question the carbon adsorption costs and cost effectiveness because (1) a device is needed for each vent (manifolding is not permitted due to the potential for cross-contamination of new or recycled chemicals), and (2) additional costs are incurred (the carbon must be regenerated or buried).

Response: Since proposal, controls were evaluated for 40 model unit cases (see Appendix C) representing ranges and combinations of solvent physical properties, total flow rates, and organic concentrations in the vent stream. Secondary condensers were analyzed for each model unit as the most likely preferred control technology. For 25 of these cases (predominantly streams with low concentrations of low-boiling/high-volatility compounds), it was determined that condensation will not achieve a 95-percent organic reduction. Both carbon canisters and fixed-bed regenerable carbon systems were costed for each of these vent streams. Appendix C presents the cost estimates for each model unit case. It was found that, for a stream with an organic emission rate greater than 0.45 kg/h (1 lb/h), a carbon bed can achieve the same emission reduction at lower cost than a carbon canister; for a stream with an organic emission rate less than 0.45 kg/h (1 lb/h), a carbon canister is more cost effective. The capital costs of the fixed-bed regenerable carbon systems ranged from $97,300 up to $202,000, and annual operating costs ranged from $40,200 to $43,500 (from $33,100 to $43,100 when a recovery credit is included). The capital cost of a carbon canister was $1,050, and annual operating costs ranged from $7,890 to $24,800 (carbon canisters are not regenerated onsite, and a recovery credit is not appropriate). The fixed-bed regenerable carbon system's operating costs include regeneration/disposal of spent carbon; the carbon canister's operating costs include carbon replacement and disposal. Therefore, the cost estimates for a fixed-bed, regenerable carbon system, including the costs of spent carbon regeneration/disposal, are substantially greater than the costs cited by Commenter AESP-00016. Carbon canister capital costs are much lower than are the costs cited, but the range of operating costs spans the cited operational costs. Because of the facility emission rate limit of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr), carbon canisters are less likely to be used than are fixed-bed regenerable systems.

With regard to the requirement of a control device for each vent, EPA acknowledges that there are instances where vent manifolding is not allowed because of potential product contamination (e.g., across units recycling chemicals in pharmaceuticals manufacturing). However, the product has already been recovered from the vents that are sources of organic emissions to the atmosphere; therefore, manifolding of the vent streams that emit to the atmosphere should not lead to a product contamination problem. Consequently, for the purpose of estimating the impacts of the standards, it was assumed that one control device would be needed per WSTF. This was done in the absence of the site-specific information needed to determine control device requirements. Although this may underestimate the control cost for a facility that chooses to install carbon adsorption control devices on more than one vent, it is potentially a very small underestimate. For example, the total annual cost of a carbon canister is comprised almost totally of annual operating costs, which are directly proportional to the emissions removed. Thus, the potential underestimate in total annual cost resulting from assuming one carbon adsorber per facility is not significant. Similarly, for the model unit fixed-bed, regenerable carbon systems, total annual operating costs ranged from 57 to 72 percent of total annual costs. Furthermore, the addition of the emission limit to the rules based on the facility organic emission rate lessens the likelihood that a facility will need to control multiple process vents to attain the allowable organic emission rate of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr).

8.2 CONDENSER COSTS

Comment: Commenter AESP-00016 questions the overall credit of $620,000 in nationwide costs for secondary condensers. According to the commenter, the assumption that secondary condensers will more than pay for themselves is based on an estimated increased yield of 20 to 30 percent. The commenter alleges that a primary condenser may provide such an increase, but the yield of a secondary condenser would not exceed 1 percent. Considering the labor costs for maintenance, he challenges the estimated credit and states that secondary condensers actually would result in substantial costs. Other commenters also question the costs because a device is needed for each vent to prevent cross-contamination due to manifolding of streams. Commenter AESP-L0018 states that the costs do not account for the more sophisticated systems needed in high-humidity areas to allow for equipment deicing or prewater removal.

Response: Because of commenters' concerns regarding the estimated condenser yields and the requirement for more sophisticated systems in high-humidity areas, a state-of-the-art computer process simulator known as ASPEN (Docket No. F-90-AESF-FFFFF, item S0012) was used in the final analyses of condenser design and cost for the model unit cases representing ranges and combinations of vent stream characteristics. The ASPEN condenser configuration consists of (1) a floating head, one-pass, shell-and-tube heat exchanger, (2) a refrigeration unit capable of producing chilled brine at a temperature of -28 °C (-20 °F), and (3) an optional primary water-cooled heat exchanger. This final item might be necessary in some instances of organics condensation to reduce the size of the refrigeration unit and to remove water vapor in order to avoid freezing problems because the condenser temperature is low enough to cause ice buildup on heat transfer surfaces. Therefore, cost estimates generated by ASPEN account for water removal.

Model unit condenser cost estimates are presented in Appendix C. For the large model unit cases (3.9 L/s or 8.3 scfm total flow rate), total annual cost with recovery credit ranged from a credit of $4,980 up to a cost of $2,800. For the medium model unit cases (0.6 L/s or 1.2 scfm total flow rate), total annual cost with recovery credit ranged from $630 up to $2,120. For the small model unit cases (0.3 L/s or 0.6 scfm total flow rate), total annual cost with recovery credit ranged from $1,770 up to $2,030.

The model unit control cost estimates and the WSTF industry profile were used to generate nationwide control cost estimates of implementing the process vent regulations (see Appendix C). The cost estimates are for 73 large facilities and 167 medium facilities. The 208 small facilities (less than 189,000 L [50,000 gal] throughput/yr as defined in the final analysis) would not be required to install emission controls under the facility process vent organic emission rate limit. Because there was insufficient site-specific information available to determine which facilities could apply condensation rather than carbon adsorption, upper and lower bound cost estimates were generated for the 95-percent emission reduction control option. The upper bound cost estimate is based on the assumption that fixed-bed, regenerable carbon adsorption systems would be required to control process vents at all facilities with organic emissions above the emission rate limit. Similarly, the lower bound cost estimate is based on the assumption that condensers could be used to control process vents at all facilities with emissions above the emission rate limit. The range in estimates of nationwide total annual cost is from a credit of $68,000 up to a cost of $12.9 million, assuming the installation of one control device per facility with emissions above the limit.

As is discussed in the response to comment 8.1, multiple control devices should not be required to prevent product contamination. In addition, available site-specific information indicates that the process emissions are released through one vent per recycling process and that many facilities only have one recycling process unit. Because emission estimates are based on total facility waste solvent throughput data, the assumption of one vent does not significantly affect the overall analysis. Furthermore, the addition of the emission limit to the rules based on the facility organic emission rate lessens the likelihood that a facility will need to control multiple process vents to attain the allowable organic emission rate of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr). Therefore, it was assumed that one control device would be needed per WSTF with emissions above the limit and that facility process emissions would be manifolded and vented to the control device if control of more than one process vent were required.

8.3 COMPLIANCE COSTS

Comment: Commenter AESP-00019 disagrees with the estimated compliance costs provided at 52 FR 3765 (February 5, 1987) of the preamble. The commenter estimates that it will cost more than $160,000 for distillate receiver controls alone, exclusive of the three distillation units for which secondary condensers already have been added. Commenter AESP-L0003 estimates a per-unit capital cost of between $500,000 and $750,000 per facility compared to EPA estimates of $30,200 to $174,500; per-unit operating costs per facility are estimated at $60,000 to $100,000 compared to EPA estimates of $13,600 to $115,000. Although the company operating costs estimates are within EPA's estimated ranges, the commenter believes that the EPA ranges are too broad (a factor of 10) to be realistic.

Response: In response to a request for additional information relative to the cost estimate of $160,000 for distillate receiver controls, Commenter AESP-00019 submitted supporting documentation. The cost estimate is based on a system that would provide a vent condenser on each storage unit in the commenter's system. There are 39 such storage units for which condensers are estimated to range in cost from $2,000 to $5,000 per unit (similar to the range in estimated condenser capital costs of $1,200 to $5,700 for small and medium model unit cases). The cost estimate of $160,000 represents an average cost of $3,500 per unit plus the cost of a utility system needed to support the operation. Although the capital cost estimates for 39 vent condensers appear to be reasonable, this regulation only covers distillate receivers releasing emissions vented from the distillation column. Therefore, storage tank vents that are not venting emissions from the distillation process are not covered by these rules.
In addition, control of process vent emissions is only required if facility process vent organic emissions exceed 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr).

With regard to the costs referenced by Commenter AESP-L0003, the compliance costs for a facility are the costs of controlling process vent emissions and the costs of controlling fugitive emissions from equipment leaks. As is discussed in the response to comment 8.1, in the post-proposal analyses of feasible control technologies, vent controls were evaluated for 40 model unit cases representing ranges and combinations of solvent physical properties, total flow rates, and organic concentrations in the vent stream. The sources of data used to define the model unit cases are described in response to comment 5.1. For each of the 40 model unit cases, a chemical engineering process simulator known as ASPEN was used to estimate the control costs for condensation. For cases where condensation would not achieve a 95-percent control in organic reduction, carbon adsorption also was costed using the EAB Control Cost Manual (Docket No. F-90-AESF-FFFFF, item S0014). Details of the cost estimates are presented in Appendix C.

The costs cited by Commenter AESP-L0003 represent compliance costs for large and mid-sized recycling model units as specified in the post-proposal analysis (Appendix C). Table 8-1 presents lower bound and upper bound estimates of mid-size recycling model unit compliance costs. The ranges are not as broad as the ranges estimated at proposal because the lower bound and upper bound process vent compliance cost estimates represent the application of condensation and fixed-bed, regenerable carbon adsorption, respectively. Either condensation or carbon adsorption is judged to be feasible in all cases; therefore, flares and incinerators are not included, although their use is not precluded by the standard. The ranges of cost estimates are still broad and would be unacceptably broad if meant to represent the range of compliance costs for a specific facility. However, the range in estimated compliance costs for process vents reflects the diversity of constituents and operating characteristics across WSTF nationwide, and therefore is realistic.

8.4 COMPLIANCE COSTS FOR LDAR PROGRAM

Comment: Commenter AESP-00017 questions the estimated compliance costs for implementation of the proposed LDAR program. The commenter cites costs at one plant with 180 valves, 2 pumps, and 1 rupture disc of $12,000 for setup (including $2,000 for instrumentation and the rest for manpower costs), plus $2,500/yr for manpower for monthly tests. Five monthly tests have found no leaks and one pump seal failure. At another site, the Table

TABLE 8-1. ESTIMATES OF MID-SIZED RECYCLING MODEL UNIT COMPLIANCE COSTS

	Per plant cost		
	Process control[a]	Fugitive control[b]	Total
Lower bound			
Capital cost, 1986 $	8,740	26,970	35,710
Annual cost, $/yr	(2,820)	11,910	9,090
Upper bound			
Capital cost, 1986 $	101,000	26,970	127,970
Annual cost, $/yr	51,300	11,910	63,210

[a] The lower bound cost estimates for process vent control represent the average costs of applying a condenser to model unit cases 6, 7, 10, 11, and 12. The upper bound cost estimates represent the average costs of applying a fixed-bed, regenerable carbon adsorption system to model unit cases 5, 8, and 9. In Appendix C, the model unit cases are specified in Table 1 of the January 26, 1988, memorandum from Robert Zerbonia, RTI, to Rick Colyer, EPA/SDB, and Robert Lucas, EPA/CPB, regarding model unit condenser in carbon adsorber cost estimates.

[b] In Appendix C, the fugitive control costs are displayed in Table 2 of the September 22, 1988, memorandum from Robert Zerbonia, RTI, to Rick Colyer, EPA/SDB, and Bob Lucas, EPA/CPB, regarding costs for fugitive emissions control at WSTF/TSDF model units.

initial setup cost was $550,000 (including $400,000 for scrubbers, instrumentation, and piping changes and $150,000 for labor). The annual cost is estimated at $16,000 for manpower to run the tests. These costs are for two different operating departments; together they have 1,350 valves, 40 pumps, and 10 relief valves. During 2 years of compliance, 2 leaking valves and 19 pump seal leaks have been detected.

Response: The facility compliance costs for the first site cited by the commenter are in line with the estimated compliance costs for implementation of the LDAR program. The estimated compliance costs are based on unit capital and annualized cost factors for each type of fugitive emission source. The unit costs were applied to model unit equipment counts to generate facility cost estimates. The mid-sized recycling model unit contains a total of 173 emission sources, including 121 valves, 5 pumps, and 3 pressure relief valves, which is a similar arrangement to the sources at the first plant mentioned by the commenter. The estimated capital costs for this facility are $27,000, and the estimated total annualized costs are $11,900 (including amortization of capital costs); both of these costs are greater than the costs cited by the commenter by factors of more than 2.

The equipment counts provided by the commenter for the second site are almost an order of magnitude greater than the mid-sized recycling model unit equipment counts and nearly four times as large as the large-sized recycling model unit used in the analysis. In this case, the capital costs are more than two times greater than the capital costs estimated for the large recycling model unit, increased in proportion to the same equipment counts. However, the capital costs include $400,000 for scrubbers, instrumentation, and piping changes. Because vent controls such as scrubbers are not required for implementation of an LDAR program, most of the capital costs cited by the commenter would not be incurred as a result of this rulemaking. Subtracting the costs for scrubbers and piping changes would bring the setup costs in line with the large model unit's capital costs, taking the differences in equipment counts into consideration. The annual costs cited by the commenter are less than one-half the estimated proportional model unit's annual costs, with capital equipment amortization factored out.

Therefore, for the two plants for which the commenter has provided information on equipment counts and compliance costs, the model unit's estimated capital costs are more than twice the cited capital costs in one case and comparable to the cited capital costs in the other case, after adjusting for differences in equipment counts and controls not required for an LDAR program. Estimated annual costs are more than twice the cited annual costs in both cases. Because of the diversity of characteristics of TSDF/WSTF nationwide, the model unit's cost estimates are not expected to agree closely with the actual control costs incurred by specific facilities. However, the model units are based on aggregated data from numerous facilities and provide a sound basis for estimating nationwide control costs.

8.5 RECOVERY CREDIT FOR TSDF

Comment: Commenters AESP-00018, AESP-L0003, and AESP-00024 do not believe that a recovery credit for the value of captured emissions is applicable to TSDF. Without a recovery credit, the costs will be higher for TSDF than for WSTF, and this merits adoption of a less burdensome standard for TSDF according to Commenter AESP-00018. Commenter AESP-00024 states that no recovery credit should be applied because there is no benefit of capturing the nonvolatiles or low organics included in the definition of "VHAP." If the definition is not changed to reflect the concerns associated with recycling, then no recovery credit should be applied.

Response: The EPA agrees with Commenters AESP-00018, AESP-L0003, and AESP-00024 in that a recovery credit is not applicable to TSDF in general because most of the hazardous wastes handled at a TSDF are destined for disposal. In contrast, at a WSTF, the air emissions resulting from equipment leaks are potentially recyclable solvents. Thus, no recovery credit was applied for TSDF other than WSTF in the analyses for the final equipment leak standards. Although it is also true that in the absence of a recovery credit the costs will be somewhat higher for TSDF than WSTF, because these standards are not based on costs, there is no basis for setting a less stringent standard for TSDF. Regarding the concerns of Commenter AESP-00024 with the definition of VHAP, as is explained in response to comment 3.2.6, the equipment-leak standards have been revised to take component volatility into consideration. Also it should be noted that to clarify the applicability of the standards, VHAP has been dropped from the promulgated rule.

8.6 COST EFFECTIVENESS OF PROCESS VENT CONTROL TECHNIQUES

Comment: Commenter AESP-00009 asks if EPA has performed any study of the cost effectiveness of incineration and carbon absorption for reducing VOC on a ton-per-year basis. Commenter AESP-L0018 asserts that, assuming the controls are appropriate from a risk standpoint, EPA should ensure the controls are cost effective for WSTF. Commenter AESP-00019 states that the BID does not include cost estimates for the control of product accumulator vessels (including distillate receivers, condensers, bottoms receivers, product separators, and hot wells).

Response: In the post-proposal analysis, the feasibility and costs of applying condensation, carbon adsorption, and incineration were evaluated for WSTF process vent streams. Ranges of vent stream and organic flow rates were used in the analyses, based on a review of available WSTF site-specific data (see responses to comments 5.2 and 5.3). Vent emission measurements from primary and secondary condensers, condensers vented to tanks, and vacuum distillation vents were reviewed. Because the regulations only apply to tank vents releasing uncondensed organics from the distillation column overhead, the emission data reviewed are representative of the wide ranges of flow rates and organic emission rates from these emission sources.

Figures 8-1, 8-2, and 8-3 present graphs of the organic emission rate (kg/h) versus the cost effectiveness ($/Mg) of condensers, carbon adsorbers, and incinerators, respectively. In each case, the cost effectiveness is fairly constant for organic emission rates above 0.45 to 1.4 kg/h (1 to 3 lb/h), but rapidly worsens as the organic emission rate drops below 0.45 to 1.4 kg/h (1 to 3 lb/h). Because the three types of add-on controls are equally protective, the choice of a control is expected to be made on the basis of cost effectiveness. From this perspective, condensation should be the preferred type of control, with carbon adsorption used on vent streams for which condensation will not achieve an adequate degree of control. Incineration might be used by a facility with a hazardous waste incinerator

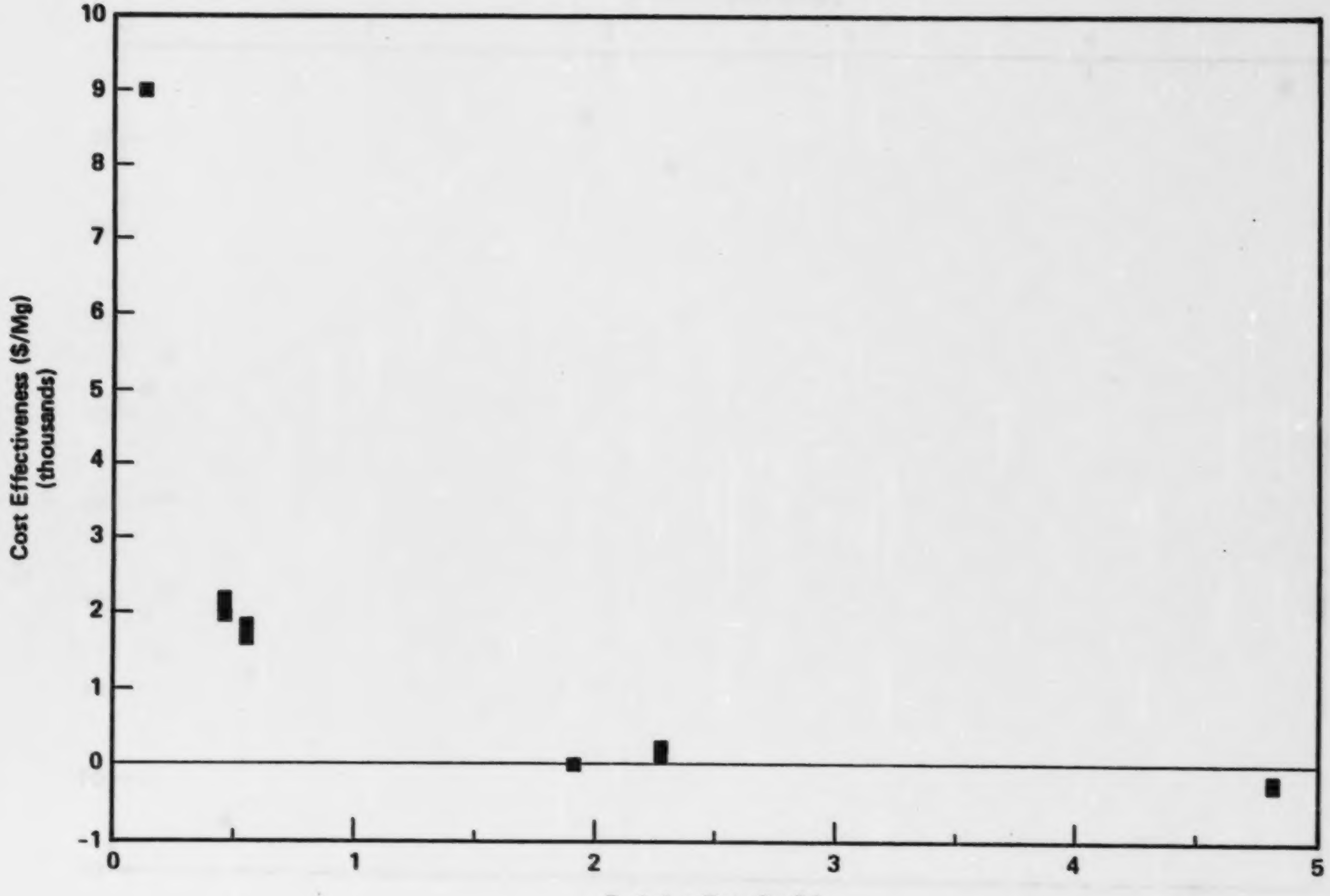

Figure 8-1. Emission rate vs. cost effectiveness (condensers @ 95%).

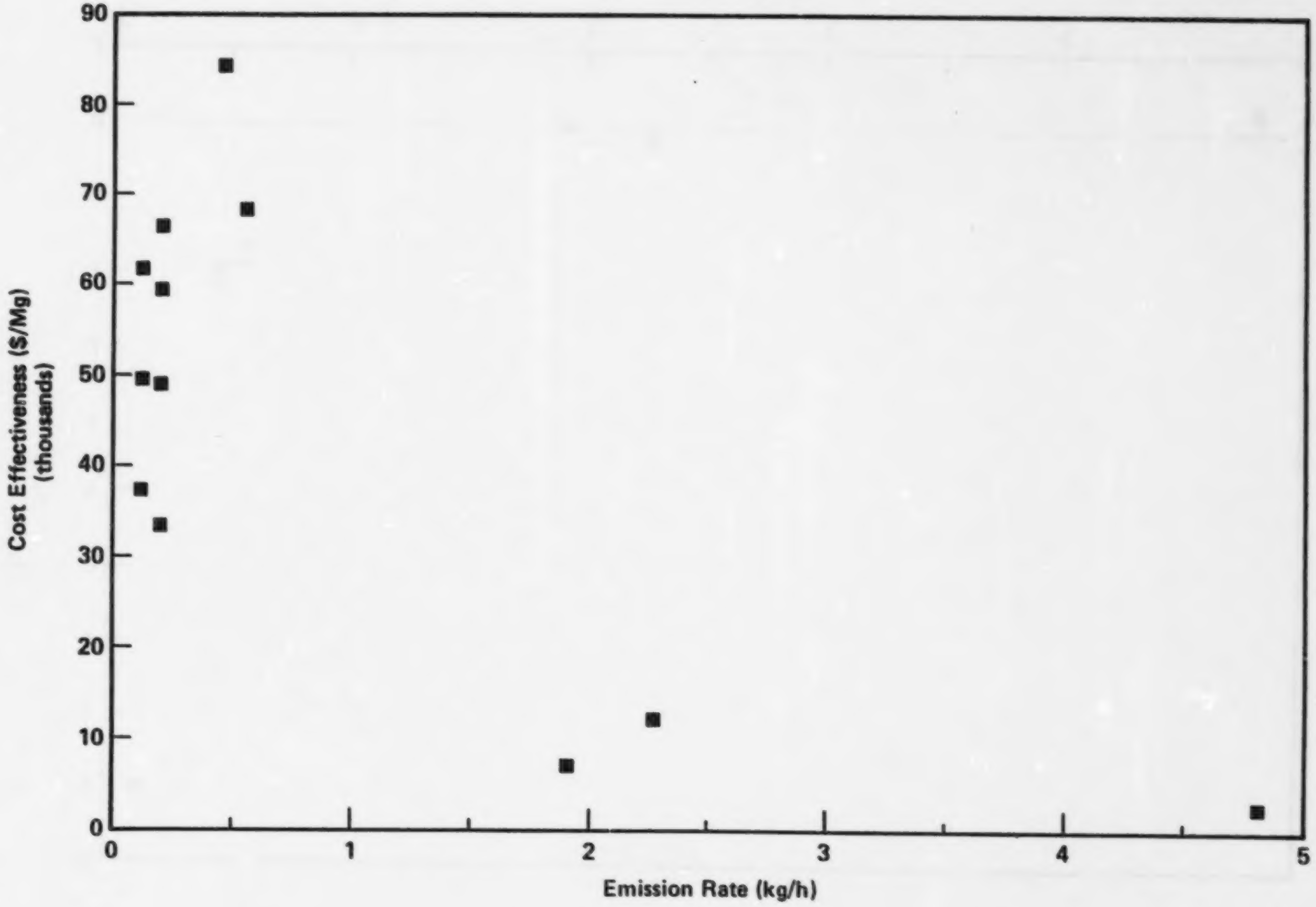

Figure 8-2. Emission rate vs. cost effectiveness (carbon adsorption).

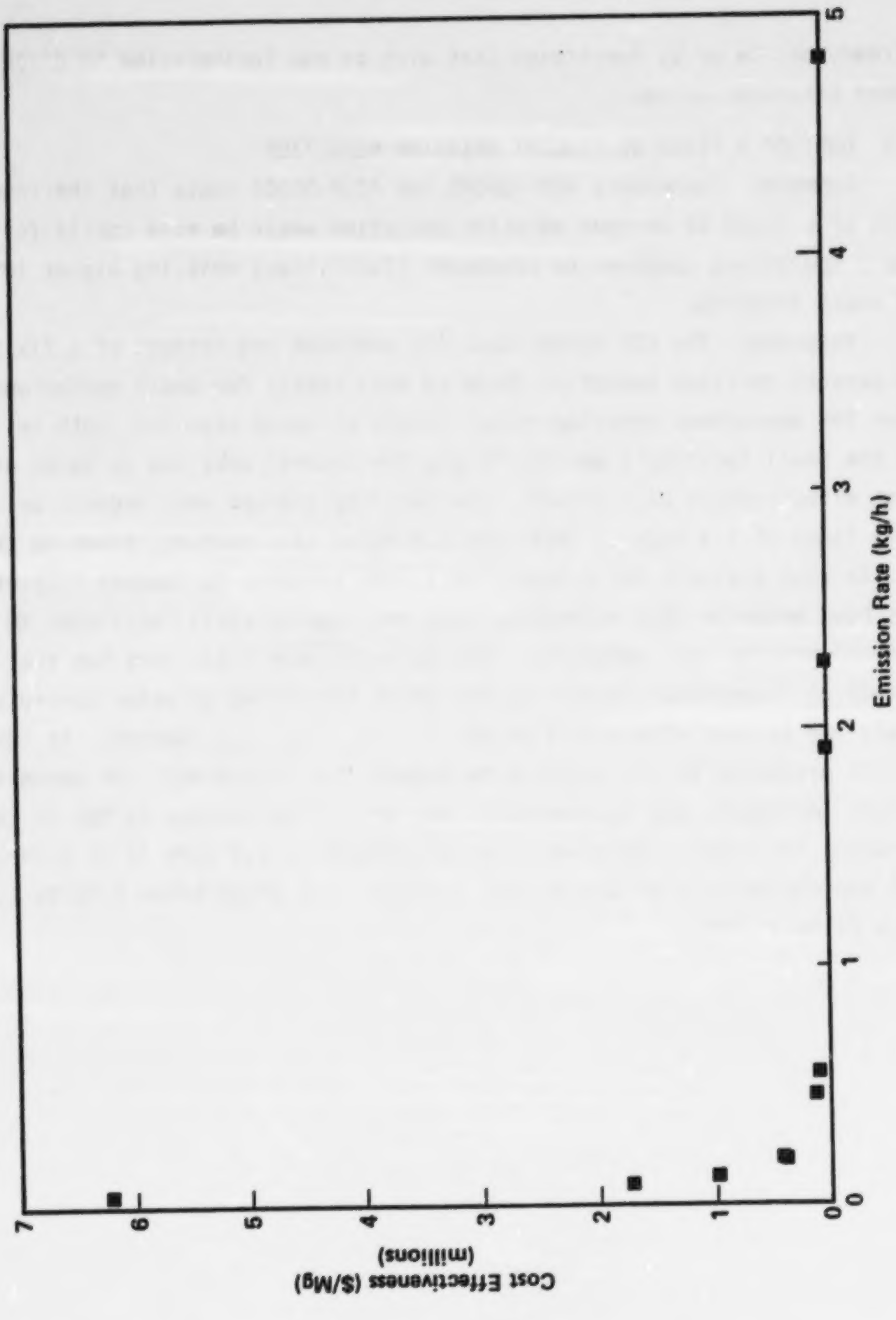

Figure 8-3. Emission rate vs. cost effectiveness (incinerators @ 98%).

already onsite or by facilities that wish to use incineration to dispose of other hazardous wastes.

8.7 COST OF A FIXED 95-PERCENT EMISSION REDUCTION

Comment: Commenters AESP-00002 and AESP-00006 state that the requirement of a fixed 95-percent emission reduction would be more costly for small operations compared to equipment (facilities) emitting higher levels of waste organics.

Response: The EPA agrees that the proposed requirement of a fixed 95-percent emission reduction could be more costly for small operations than for operations emitting higher levels of waste organics, both in terms of the small facility's ability to pay the control cost and in terms of the cost effectiveness of controls. The facility process vent organic emission rate limit of 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr), based on the health risk analysis for process vents (see response to comment 7.1), that has been added to this rulemaking does not require small facilities to control process vent emissions. The emission rate limit thus has the effect of "exempting" facilities for which installing emission controls would not be cost effective from the process vent requirements. As the graphs presented in the response to comment 8.6 illustrate, for condensers, carbon adsorbers, and incinerators, the cost effectiveness ($/Mg) is fairly constant for organic emission rates above 0.45 to 1.4 kg/h (1 to 3 lb/h), but rapidly worsens as the organic emission rate drops below 0.45 to 1.4 kg/h (1 to 3 lb/h).

9.0 ECONOMIC IMPACTS

9.1 SMALL BUSINESS IMPACTS

Comment: Three commenters (AESP-00016, AESP-00036, and AESP-00009) object to the preamble certification that the proposed standards will not have a significant impact on a substantial number of small business entities. In support, Commenter AESP-00016 states that all but three or four member companies in the NASR are small businesses with an average of fewer than 30 employees. Commenter AESP-00036 says that 90 percent of all commercial recycling facilities in the United States are family-owned businesses. Commenter AESP-00009 states that the typical recycler has one or two stills and employs fewer than 100 people. Commenter AESP-00016 requests to review and comment on the documentation used to support the certification and states that EPA should perform a Regulatory Flexibility Analysis. Commenters AESP-00002, AESP-00005, and AESP-L0018 generally feel that the standards would have an adverse economic impact on small businesses and would have a significant impact on large businesses.

Response: After completing the revised estimates of the compliance costs resulting from the regulation, EPA examined whether the regulation would have "a significant economic impact on a substantial number of small entities." (See "Economic Impact of Air Emissions Regulations: Waste Solvent Recycling," Docket No. F-90-AESF-FFFFF, item S0046.) A "substantial number" is generally thought to imply greater than 20 percent of the small entities, although this is not a fixed rule. A "significant economic impact" is said to occur whenever any of the following criteria is satisfied:

- Annual compliance costs (including annualized capital, operating, and reporting costs) increase total costs of production for small entities for the relevant process or product by more than 5 percent.

- Compliance costs as a percent of sales for small entities are at least 10 percent higher than compliance costs as a percent of sales for large entities.

- Capital costs of compliance represent a significant portion of capital available to small entities, considering internal cash flow plus external financing capabilities.

- The requirements of the regulation are likely to result in closures of small entities.

An estimated 450 recycling facilities will be directly affected by this rule. From financial data bases, information was obtained regarding the number of employees and the company's sales for the affected facilities. Using the Regulatory Flexibility Act guidelines, these data were compared to the Small Business Administration criteria that apply to each Standard Industrial Classification (SIC) code to determine the extent of small firms. It should be noted that the criteria are focused on the firm, not the facility. For some of the facilities, it was impossible to find any information about their sales or number of employees. Therefore, to bound the estimates of the number of small businesses, it was assumed that the firms for which no information is available are either all small businesses or none (small business) at all. Using this sensitivity analysis approach, a range of 12 to 146 captive facilities are owned by small businesses; a range of 0 to 70 commercial facilities are owned by small businesses.

Faced with higher recycling costs, firms that own captive facilities will presumably choose the least-cost option between incurring those costs, using offsite management, or changing their production process to reduce generation of spent solvents. While some firms may decide to shut down their recycling units, this is not expected to result in much of an impact on the overall activities of the firm. The projected product price increases in Table 9-1 reflect the insignificant component of product costs represented by recycling. Given price changes of much less than 0.1 percent, it is reasonable to conclude that captive facilities owned by small businesses will not be disadvantaged as compared with larger firms.

The price increases are larger in the commercial sector in which the service provided is recycling rather than, for example, the production of

TABLE 9-1. PRICE AND QUANTITY ADJUSTMENTS IN THE MARKETS FOR GOODS AND SERVICES BY GENERATING SECTOR, EQUIPMENT LEAK FUGITIVE EMISSION CONTROL

Sector	Low-cost process vent emissions controls		High-cost process vent emissions controls	
	Change in quantity produced, %	Change in price, %	Change in quantity produced, %	Change in price, %
Mining	-0.00059	0.00085	-0.00074	0.00105
Grain and textile mill products	-0.00423	0.00605	-0.00524	0.00749
Furniture, paper products, printing	-0.00083	0.00118	-0.00102	0.00146
Industrial chemicals, inorganic and organic	-0.00460	0.00687	-0.00570	0.00851
Plastics, fibers	-0.00068	0.00423	-0.00084	0.00524
Biological, pharmaceutical, medical chemicals	-0.00694	0.01004	-0.01107	0.01244
Assorted chemical products	-0.00865	0.00994	-0.01072	0.01232
Paint and allied products, petroleum and coal	-0.00038	0.00164	-0.00047	0.00203
Rubber, plastics	-0.00010	0.00074	-0.00012	0.00091
Cement companies	-0.00044	0.00063	-0.00055	0.00078
Primary metals	-0.00056	0.00080	-0.00069	0.00099
Metal fabrication	-0.00044	0.00063	-0.00054	0.00078
Nonelectrical machinery	-0.00052	0.00275	-0.00065	0.00340
Electrical machinery and supplies	-0.00104	0.00175	-0.00228	0.00217
Transportation equipment	-0.00055	0.00066	-0.00068	0.00082
Instruments	-0.02286	0.03286	-0.02832	0.04046
Miscellaneous manufacturing	-0.00591	0.00615	-0.00732	0.00762
Electric and gas utilities	-0.00116	0.00061	-0.00144	0.00076
Nondurable goods: wholesale sales	-0.00051	0.00073	-0.00063	0.00090
Research laboratories, hospitals, universities, consultants	-0.00179	0.00061	-0.00221	0.00076

industrial chemicals. Such increases range from 1.76 to 2.18 percent. However, recycling is only one of many hazardous waste management services offered by many of these facilities. In that case, it is unlikely that decreased recycling will result in shutting down the facility. In some cases, however, recycling is the only form of hazardous waste management service offered by the facility. In such instances, some very small-volume facilities may be uneconomical. Whether these facilities will actually close is unclear. There are several mitigating reasons for this: (1) The volume of recycling is expected to increase over time. Thus, at the same time that the regulation is decreasing the supply of commercial recycling services, the demand for these services is increasing. The net effect on volume recycled is impossible to predict. (2) In fact, reductions in recycling are likely to be distributed across all the facilities in the industry, rather than being concentrated in only the facilities operating very small units. Thus, all the firms would decrease their recycling activities slightly, and no facilities would be shut down. (3) The permitting process is long and costly; a permit represents an asset to the firm, which would be made more valuable as the price of recycling services increases. The firm may decide not to sacrifice the permit by shutting the facility down. (4) The costs of closure can be very substantial. Thus, whereas a firm may be adversely affected by the increased cost of recycling, it will probably be reluctant to shut down the facility even if it is temporarily uneconomical to operate.

9.2 CLOSURES AND OTHER ECONOMIC IMPACTS

Comment: Numerous commenters stated that the proposed rules will cause closures and ask if EPA has evaluated this economic impact and the additional economic impacts not included in the cost estimates, such as the cost of more insurance and the additional costs that will be incurred for becoming repermitted at the State and Federal level to obtain approval for the previous exemption for recycling. Commenter AESP-00009 cites a cost of over $1 million to reopen with new permits. Commenters AESP-00009 and AESP-00016 request EPA to evaluate the economic impact of lost recycling capacity, including (1) decreased production, increased material remaining as natural resources for future use, decreased imports, and decreased material for waste disposal. Commenters AESP-00002, AESP-00005, and AESP-00009 claim that the economic impact will discourage recycling, will put commercial recyclers at a competitive disadvantage with onsite and unpermitted recycling operations, and will increase the volume of solvent into the alternative fuels program at the expense of recycling. Commenter AESP-L0003 states that, if higher costs of emission control are imposed on a TSDF reclaimer, then materials will shift to non-TSDF reclaimers without emissions controls. This is the opposite of the Agency's intent and will cause TSDF to shift material to less efficient units.

Response: With regard to comments concerning the costs of re-permitting, the standards have been revised to require the inclusion of units affected by these rules only at permit reissue under Section 124.15 or review under Section 270.50, provided the permit has been issued prior to the effective date (promulgation date plus 6 months) of these rules. Therefore, the additional costs associated with re-permitting are expected to be minimal.

In response to comments regarding the economic impacts on recycling, EPA performed an economic analysis (Docket No. F-90-AESF-FFFFF, item S0046) using the control costs described in Chapter 8.0. The unit costs of control based on average process vent compliance costs exhibit significant economies of scale. Small recycling facilities (facilities recycling up to 189,000 L [50,000 gal/yr]) are estimated to cost $27/Mg of recycling throughput to control; large facilities are estimated to cost $11/Mg of recycling throughput. The compliance costs are associated with an increase of 1.76 to 2.18 percent in the price of commercial waste solvent recycling services and a 1.59- to 2.27-percent decrease in the quantity of these services, assuming the implied waste minimization is economically feasible. The increases in the prices of goods and services where solvents are used as a productive impact are virtually nonexistent. Spent solvent management costs represent less than 0.1 percent of production costs for all generators of spent solvents.

Because of the economies of scale in compliance and because onsite recycling facilities tend to be smaller (119 Mg median volume recycled) than commercial facilities (1,103 Mg median volume recycled), some shift in waste solvent recycling from onsite to offsite commercial facilities is projected. This shift, if it does occur, would potentially be accompanied by the closure of a large number (around 195 units) of very small recycling units, with an associated decrease of between 10 and 12 jobs (full-time equivalent employees per year). It is important to note, however, that these are not plant closures. The closure would represent taking off-line small volume distillation units within a plant that produces, for example, industrial chemicals.

Furthermore, there would be a number of legal and economic reasons why captively owned recycling facilities would not close even if the analysis performed indicated that they would. For example, there may be insufficient commercial capacity located near the plant, so that transportation costs would make shipping offsite uneconomical. Or the firm may decide it can reduce its legal risk by recycling the spent solvent onsite. Similarly, a firm may feel that, for a small volume of throughput, the advantages of having control over scheduling the recycling operation outweigh the cost savings of using a commercial recycler. Thus, unit closures at captive plants are probably overestimated by some unknown amount. Recycling unit costs for captive recyclers represent only a very small fraction (averaging less than 0.03 percent for captive recyclers) of their total production costs. The increase in recycling costs resulting from the regulation may in some cases cause a facility to shut down its recycling unit, but it will have virtually no impact on the production activities of captive facilities. (Sector output of goods and services decreases by at most 0.03 percent in response to the regulation.) Because of the existence of economies of scale in compliance, the commercial recycling sector is projected to experience a smaller decrease in output than the onsite recycling sector.

10.0 TEST METHODS

10.1 MEASUREMENT OF THE 10-PERCENT TOTAL ORGANICS

Comment: Five commenters (AESP-00013, AESP-00019, AESP-00024, AESP-00032, and AESP-L0001) provide their views on the test methods proposed for determining applicability of the equipment leak standards. Commenter AESP-00013 states that volatile compounds nonreactive in the formation of ozone should not be included in calculation of the stream's organic content; the measurement method should be for volatile chemicals and not total organics. Commenter AESP-00019 recommends using a total hydrocarbons measurement because equipment that handle chlorinated hydrocarbons also should have to comply with the standards. Commenter AESP-00024 recommends Method 8240 of SW-846, which detects both volatile and relatively low-volatility compounds, for determining applicability over Method 9060, which detects nonvolatile or nonhazardous materials and would be costly and duplicative. Commenter AESP-00032 agrees in that no conclusions can be drawn regarding the concentration of VOC in a waste using a TOC analysis. The commenter points to the inconsistency of requiring additional monitoring if a TSDF managed a hazardous waste with constituents in the low parts per million ranges while not regulating up to 10 percent of the pure constituent in an aqueous waste based on TOC, an unrelated parameter. Commenter AESP-L0001 agrees with the other commenters that the test method should consider the volatility of the wastes.

However, Commenter AESP-L0001 notes than no analytical method currently exists that will measure 10-percent TOC in both a solid and liquid waste. He states that Method 9060 determines the TOC of water and waste via the conversion of all organic carbon to carbon dioxide, making no distinction as to the types of organic compounds present (e.g., volatile vs. nonvolatile organics). Many solid or water-insoluble viscous liquid wastes cannot be tested by this method. Method 8240 is designed to measure only selected VOC in water and wastes; use of this method would require development of compound-specific criteria. Extensive interlaboratory studies also would be needed to determine the precision and accuracy at the high concentrations (i.e., 10 percent) at issue in the standards because the method is designed to measure concentrations in the parts per million range. Finally, TOC is not equivalent to total hydrocarbon because of the presence of hydrogen, oxygen, or other heteroatoms in the organic molecules. Alternatively, Method ASTM D 2267-68 does not provide a measure of total hydrogen, but only the aromatic components of petroleum-derived fuels. Methods ASTM E 169-63, E 168-67, and E 260-73 provide general guidance to users of ultraviolet (UV), infrared (IR), and gas chromatography (GC) techniques, but these practices do not contain any detailed methods for determining TOC or specific organic compounds. The commenter explains that determining total VO would be a more realistic measure of emission potential than total organics, but existing methods for VO are compound-specific. The commenter encourages EPA to continue developmental efforts for a total VO method and apply it.

Response: The determination of applicability was intended to be based on the total organic content of the waste stream. The standards cover organic emissions and are intended to reduce impacts on human health and the environment associated with total organics. The basic reason for measuring total organics is that the original collection of data used to support the standards measured total organics. In practice, most organic wastes and their derivatives affected by these standards are considered volatile. In addition, the promulgated equipment leak standards have been drafted to distinguish between sources containing or coming into contact with wastes which are more or less volatile, i.e., the light versus heavy liquid criterion. If the total organic content of the waste stream never equals or exceeds 10 weight percent, no controls are required. Commenters AESP-00019, AESP-00024, AESP-00032, and AESP-L001 noted that the various proposed test methods all had limitations and none were universally applicable. The EPA recognized this and therefore proposed the use of several test methods. The determination of applicability should not require precise measurement of the 10 weight percent total organic in most cases. The EPA anticipates that most waste streams will have an organics content much lower or much higher than 10-percent. Furthermore, because the regulation requires control if the organic content of the waste stream ever equals or exceeds the 10-percent value (Sections 264.1063[d] and 265.1063[d]), EPA believes that owners or operators will not claim that a waste stream is not subject to the requirements of the standard based on a sample analysis with results near 10 percent. The precision of the measurement results will be considered in determining if the organic content of the waste stream is ever expected to exceed the 10 percent value and is thus not critical.

If the facility does decide to test the waste, the choice of the appropriate method must be based on a knowledge of the process and waste. The EPA has prepared a guidance document that includes information to aid TSDF owners/operators and enforcement and permitting personnel in implementing the regulations. Additional detail is provided in the guidance document to aid in choosing the most appropriate test method (refer to "Hazardous Waste TSDF--Technical Guidance Document for RCRA Air Emission Standards for Process Vents and Equipment Leaks").

After proposal, EPA considered the commenters' concerns that volatility of the waste stream should be considered in the equipment leak rules. As a result, the LDAR provisions of the regulation were changed to establish two potential levels of required monitoring. Those processes with the greater emission potential are designated to be in gas/vapor service or light liquid service and are required to implement a more restrictive LDAR program. Those processes with a lesser emission potential are designated to be in heavy liquid service and are required to implement a less restrictive LDAR program. The determination of being in light liquid service as opposed to heavy liquid service is based on the concentration of organic components in a waste whose pure vapor pressure exceeds 0.3 kPa. This addresses the commenters' concerns that volatility of the waste stream should be considered.

To determine whether a particular waste managed in a hazardous waste management unit of the type specified in the rule (e.g., a steam stripping or air stripping unit) is subject to the provisions of Subpart AA of Parts 264 and 265, the owner/operator is required to conduct a determination of the waste's total organic concentration initially (by the effective date of the standards or when the waste is first managed by a waste management unit) and thereafter on a periodic basis (for continuously generated wastes).

A waste determination would only be necessary for Subpart AA applicability when an owner/operator manages the waste in a distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operation that is not controlled for organic process vent emissions. Waste determinations would not be necessary for wastes managed in (affected) units that are controlled for organic emissions to meet the substantive requirements of Subpart AA.

Determination that the time-weighted, annual average total organic concentration of the waste managed in the unit is less than 10 ppmw must be performed by direct measurement or by knowledge of the waste as described later in this section. Direct measurement of the waste's total organic concentration must be performed by collecting individual grab samples of the waste under process conditions expected to result in the waste having maximum organic concentration and analyzing the samples using one of the approved reference methods identified in the rule.

The EPA is also requiring that analytical results for a minimum of four representative samples be used to determine the total organic concentration for each waste stream managed in the unit. In setting the minimum number of samples at four, EPA will obtain sufficient data to characterize the total organic concentration of a waste without imposing an unnecessary burden on the owner/operator to collect and analyze the samples.

As an alternative to using direct measurement, an owner/operator is allowed to use knowledge of the waste as a means of determining that the total organic concentration of the waste is less than 10 ppmw. Examples of information that shall be considered by EPA to constitute sufficient knowledge include: (a) documentation that organics are not involved in the process generating the waste; (b) documentation that the waste is generated by a process that is identical to a process at the same or another facility which has previously been demonstrated by direct measurement to have a total organic content less than 10 ppmw; or (c) previous speciation analysis results from which the total concentration of organics in the waste can be computed. The final standards include the provisions that EPA can require that the waste be analyzed using Method 8240 if EPA finds the documentation is insufficient to determine an exception by knowledge of the waste.

In order to address the temporal variability that can occur both within a particular waste stream and within the various waste streams managed in a hazardous waste management unit, the final rules require a time-weighted, annual average concentration to characterize the waste managed in the unit. The final rules require that an owner/operator repeat the waste determination whenever there is a change in the waste being managed or a change in the process that generates or treats the waste or, if the waste and process remain constant, at least annually. For example, continuous processes are more likely to generate a more homogenous waste than batch operations; batch operations involve processes that may frequently involve change in materials or process conditions. Batch operations, therefore, usually generate wastes with varying characteristics, including such characteristics as organics content. Ground water concentrations would also be expected to show significant variation if more than one well provides influent to a waste management unit such as an air stripper and the wells that feed the unit are varied over time or if the proportions from the wells that make up the influent are changed. This is because there is typically considerable spatial variability in contaminated ground water concentrations. The situation where feed wells are changed and the change is not accounted for in the initial waste determination would be considered a process change or change in the waste being managed that would require a new determination.

With the time-weighted, annual average applicability criterion, a hazardous waste management unit would not be subject to this rule if it occasionally treats wastes that exceed 10 ppmw if at other times the wastes being treated in the unit were such that the weighted annual average total organic concentration of all wastes treated is less than 10 ppmw. The time-weighted, annual average is calculated using the annual quantity of each waste stream managed in the unit and the mean organic concentration of the waste stream.

The location where the waste volatile organic content is determined is also of importance since sampling location can greatly affect the results of the determination. This occurs because the concentration level can decrease significantly after generation as the waste is transferred to various waste management units.

If the waste is directly or indirectly exposed to ambient air at any point, a portion of the organics in the waste will be emitted to the atmosphere, and the concentration of organics remaining in the waste will decrease. For highly volatile organic compounds such as butadiene, all of the compound would evaporate within a few seconds of exposure to air. Similarly, emissions of organics from open waste transfer systems (e.g., sewers, channels, flumes) are expected to be very significant. To ensure that the determination of total organic concentration is an accurate representation of the emission potential of a waste upon generation, it is essential that the waste determination be performed at a point as near as possible to where the waste is generated, before any exposure to the atmosphere can occur.

For the reasons stated above, the waste determination must be based on the waste composition before the waste is exposed, either directly or indirectly, to the ambient air. Direct exposure of the waste to the ambient air means the waste surface interfaces with the ambient air. Indirect exposure of the waste to the ambient air means the waste surface interfaces with a gas stream that subsequently is emitted to the ambient air. If the waste determination is performed using direct measurement, the standards would require that waste samples be collected from an enclosed pipe or other closed system which is used to transfer the waste after regeneration to the first hazardous waste management unit. If the waste determination is performed using knowledge of the waste, the standards would require that the owner or operator have documentation attesting to the volatile organic concentration of the waste before any exposure to the ambient air.

The location where the waste determination would be made for any one facility will depend on several factors. One factor is whether the waste is generated and managed at the same site or the waste is generated at one site and transferred to a commercial TSDF for management. Another important factor is the mechanism used to transfer the waste from the location where the waste is generated to the location of the first waste management unit (e.g., pipeline, sewer, tank truck). For example, if a waste is first accumulated in a tank using a direct, enclosed pipeline to transfer the waste from its generation process, then the waste determination could be made based on waste samples collected at the inlet to the tank. In contrast, if the waste is first accumulated in a tank using an open sewer system to transfer the waste from its generation process, then the waste determination would need to be made based on waste samples collected at the point where the waste enters the sewer before the waste is exposed to the ambient air. For situations where the waste is generated off-site, the owner or operator may make the determination at the inlet to the first waste management unit at the TSDF that receives the waste provided the waste has been transferred to the TSDF in a closed system such as a tank truck and the waste is not diluted or mixed with other waste.

If a waste determination indicates that the total organic concentration is equal to or greater than the applicability criteria, then the owner or operator would be required to comply with the standards.

10.2 DETERMINATION OF EQUIPMENT IN VHAP SERVICE

Comment: Commenter AESP-00003 objects to the use of weight percent when defining "in VHAP service" in gaseous samples. The commenter contends that it would be unnecessarily difficult to determine percent by weight of a class of components (i.e., VO) in gaseous samples where volume fractions are more commonly measured. Commenter AESP-00014 states that determining whether a vent on a covered tank is in VHAP service will be difficult to measure because the organic vapors in the headspace will not mix homogeneously in the tank's headspace. At times, the displaced gases will contain less than 10-percent VHAP when more than 10-percent VHAP may be present.

Response: First, it should be noted that for clarity the term "in VHAP service" has been dropped from the promulgated regulations and the applicability has been more specifically defined. Weight percentage is the unit of choice when the determination of applicability is made on a solid, liquid, or sludge waste and is commonly associated with these types of wastes. It is true that volume fractions are more commonly reported for gaseous streams as asserted by Commenter AESP-00003. However, it is not easier to calculate the volume fraction rather than weight fraction. Additional information on the calibration standard used, the carrier gas in the standard, and both the organic and other inorganic gases in the sample are required in both cases. For simplicity, the units of the standard are uniformly weight percent. Additional detail will be provided in the guidance document concerning the conversion of the results of the methods to weight percent as required by the regulation.

With regard to the difficulties of obtaining a representative headspace sample in covered storage tanks, this comment is valid in certain cases, but is only relevant if this is the location chosen to collect a sample to determine if an associated process vent is subject to the standard. Additional detail will be provided in the guidance document on proper siting of a sampling location. This is the type of issue that will be worked out in the permit. It must also be pointed out that if it is determined that equipment ever contains or contacts wastes with greater than 10 percent organics, it is covered by the standards. Applicability does not vary from waste to waste (or test to test) for the same equipment.

10.3 FUGITIVE EMISSION MONITORING BY METHOD 21

Comment: Two commenters (AESP-00019 and AESP-L0011) do not support the use of portable organic vapor analyzers for leak detection. Commenter AESP-00019 points to the difficulty of obtaining accurate readings at WSTF because VO levels tend to be elevated due to the large number of pieces of equipment, amount of processing, time and humidity conditions, and the need to continually use connect/disconnect systems to operate a facility. These problems are particularly true in enclosed settings such as solvent storage areas; the commenter recommends that some allowance be made for measuring VO under these conditions. Commenter AESP-L0011 objects because the monitoring device is labor intensive, inefficient, costly, and not nearly as sensitive as the automated, computer-controlled instrument installed at his facility for the continuous monitoring of fugitive emissions. This system, according to the commenter, is capable of monitoring fugitive emissions at multiple interior locations at a fraction of the concentrations required by the proposed standards.

Commenter AESP-00012 is concerned that workers conducting monitoring of equipment with more than 10-percent VO using a nonspecific, direct-reading organic vapor analyzer will not be adequately protected. He submits that the National Institute of Occupational Safety and Health (NIOSH) recommends that workers be provided with appropriate protective equipment and clothing (including eye protection) while performing these duties. For further information on occupational safety and health considerations at TSDF, he recommends NIOSH publication 85-115 (Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities).

Response: Commenter AESP-00019 felt that it would be difficult to obtain accurate readings during equipment leak detection inspections because of varying background conditions and suggests that some allowance be made. The EPA proposed two levels of instrument readings. The one that defines when a leak is detected, i.e., a 10,000-ppm reading using EPA reference Method 21, should not be sensitive to ambient levels. The no detectable emission reading is defined in the Method 21 as the difference between the instrument reading at the point of interest and the local background reading. Therefore, the regulation does take into account the possibility of elevated background levels.

Commenter AESP-L0011 proposes to use an automated, computer-controlled instrument installed to monitor fugitive emissions at multiple locations within the plant in lieu of a leak detection inspection with a portable vapor analyzer. The periodic leak detection inspection is intended to pinpoint leaks at specific process equipment and to target them for repair. It is unclear how the suggested automated ambient fugitive emission monitoring system would pinpoint which pump, valve, flange, etc., was leaking unless each pump, valve, etc., was monitored. Provided this could be adequately designed to pinpoint leaks at specific process equipment and the detector used to measure the concentration met the performance criteria specified in Method 21, EPA has no objections to the use of an automated system. In this regard, the promulgated standards for equipment leaks contain provisions for alternative means of emission limitations.

Commenter AESP-00012 was concerned that the workers conducting the leak detection inspection would not be adequately protected. The EPA agrees that adequate safety procedures should be followed. Because of the wide range of situations expected to be encountered, it is impractical, as well as outside of the regulation's scope, to specify safety procedures in this regulation. However, there is a copy of NIOSH publication 85-115 (Occupational Safety and Health and Guidance Manual for Hazardous Waste Site Activities) in the docket for this rulemaking (see Docket No. F-86-AESP-FFFFF, item 00012.A). There are also provisions in Sections 264.1064(g) and 265.1064(g) that allow the owner or operator to designate and exempt from monthly monitoring specific valves as unsafe to monitor. The owner or operator of the valve must demonstrate that the valve...is unsafe to monitor because monitoring personnel would be exposed to an immediate danger as a consequence of monitoring; and a written plan must be followed that requires monitoring of the valve as frequently as practicable during safe-to-monitor times.

11.0 IMPLEMENTATION AND COMPLIANCE PROVISIONS

11.1 COMPLIANCE DATES

11.1.1 Overall Standards

Comment: Seven commenters (AESP-L0001, AESP-L0006, AESP-00020, AESP-00024, AESP-00033, AESP-00003, and AESP-00035) believe that more time is needed to comply to the standards than is allowed by Section 269.33 of the proposed standards. Specifically, Commenter AESP-L0001 states that the proposed rule does not address compliance dates for units or equipment that may be subject to the rule in the future. The proposed rule ties compliance to 6 to 24 months after promulgation of the regulations and so does not address units or equipment that will be first subject to the air emissions regulations months or years after the regulations are promulgated. According to Commenter AESP-L0001, because the effective date of a RCRA regulation is usually 6 months after the date of promulgation, the proposed rule would require the design to be completed 12 months after promulgation, yet construction would commence 9 months after promulgation. This schedule would require construction to commence before the design is completed. The commenter suggests allowing compliance within 24 months after the date of promulgation or within 24 months after the equipment becomes subject to the regulation, whichever occurs later. This commenter also contends that the standards should allow for procedural delays resulting from major permit modifications that are required to add monitoring and control devices to permitted facilities; a major modification takes a minimum of 12 to 18 months to account for public participation requirements and control devices cannot be installed until after the modification is made. The commenter recommends that EPA require compliance within a reasonable time after the permit modification has been issued or to amend 40 CFR 270.42 to specify that all changes necessary to comply with the air standards are minor permit modifications. Commenters AESP-L0006 and AESP-00033 note that the compliance period for interim status facilities is specified, but no similar period is provided for TSDF that have a final permit. According to Commenters AESP-00020 and AESP-00035, a lead time of greater than 24 months is needed to program needed funds, design cost-effective systems, and start construction; they recommend between 36 and 48 months. Commenter AESP-00033 agrees and asks that provisions be made for extensions on a case-by-case basis. In comparison, Commenter AESP-00003 states that the 24-month deadline appears to be achievable, but that the standards should not dictate a step-by-step compliance schedule for interim-status facilities.

Response: Under RCRA statutory requirements, compliance must be attained by the effective date of the rule (promulgation date plus 6 months). However, the final rules allow facilities that cannot install the control devices and closed-vent systems required to comply by the effective date to complete an implementation schedule that ensures compliance no later than 18 months after the effective date of the statutory or regulatory amendments under RCRA (e.g., a new listing or identification of a hazardous waste) that render the facility subject to Subpart AA or BB. The implementation schedule must be in the operating record on the effective date of the statutory or regulatory amendment. The facility also must document a rationale of why installation of the emission controls cannot be completed at an earlier date. The EPA considers the implementation schedule approach as reasonable for facilities that cannot install emission controls in 6 months and the 24-month schedule a realistic estimate of the maximum timeframe needed to install a control device and closed-vent systems, based on Section 112, CAA regulations which also contain provisions that allow up to 2 years for installation of a control device. The 24-month schedule allows time for testing, design, evaluation, fabrication, and installation. Therefore, no provisions have been made in the standards for extensions beyond 2 years on a case-by-case basis.

The final standards have been revised to require a TSDF with a final permit issued before the effective date to incorporate the requirements of the standards only at permit review under Section 270.50 or reissue under Section 124.15. Therefore, the standards do not require a permit modification. A 24-month implementation schedule is not allowed for waste management units or equipment starting operation after the effective date of Subparts AA and BB because owners or operators will be aware of the requirements of the rule and are expected to plan in advance for control devices and closed-vent systems. However, waste management units or equipment that become newly regulated units because of a newly listed hazardous waste will have 24 months from the effective date of the rule establishing the new listing or identification to complete installation and begin operation. The EPA agrees that the Agency should not dictate step-by-step implementation schedules because each affected facility needs some flexibility to budget funds, perform engineering evaluations, and complete construction; therefore, the interim dates in the schedule have been dropped.

Under the approach discussed above, the standards promulgated today for process vents and equipment leaks would be implemented on the following schedule for existing TSDF:

- 180 days following promulgation, the standards become effective; all facilities become subject to the new standards.
- On the effective date of the standards, compliance with the standards is required. Each facility that does not have the control devices required by the standards in place must have one of the following in the facility's operating record: (1) an implementation schedule indicating when the controls will be installed and in operation, or (2) a process vent emission rate determination that documents that the emission rate limit is not exceeded (therefore, process vent emission controls are not required).
- No later than 18 months following the effective date (2 years following promulgation), any control devices required by the standards for process vents and equipment leaks must be installed and in operation at all facilities.
- All permits issued after the effective date must incorporate the standards.

An existing solid waste management unit may become a hazardous waste management unit requiring a RCRA permit when a waste becomes newly listed or identified as hazardous. Owners and operators of facilities not previously requiring a RCRA permit who have existing units handling newly listed or identified hazardous waste can submit a Part A application and gain interim status. The air emission standards promulgated today would be implemented at these facilities on the following schedule:

- 180 days following the date the managed waste is listed or identified as hazardous, the standards become effective; facilities become subject to the standards.
- On the effective date of the standards, each facility that does not have the control devices required by the standards in place must have one of the following in the facility's operating record: (1) an implementation schedule indicating when the controls will be installed and in operation, or (2) a process vent emission rate determination that documents that the emission rate limit is not exceeded (therefore, process vent emission controls are not required).
- No later than 18 months following the effective date, the controls required by the standards must be installed and in operation at all facilities.

Newly constructed TSDF are required to submit Part A and Part B permit applications, and to receive a final permit prior to construction as required by Section 270.10. Following the effective date of the standards promulgated today, a Part B application for a new facility must demonstrate compliance with the standards as contained in Part 264, if applicable. Therefore, all controls required by the standards would have to be in place and operating upon startup.

Similarly, new waste management units added to existing facilities would have to be equipped with the required controls prior to startup. For a new unit added to an existing permitted facility, a permit modification would be necessary. Where a new unit is added to a facility in interim status, the owner or operator must submit a revised Part A application (Section 270.72[c]), including an explanation of the need for the new unit, and then receive approval from the permitting authority.

For facilities with hazardous waste management units that previously were not subject to control requirements because the wastes in the units did not contain organics in concentrations equal to or greater than the applicability criteria of 10 ppmw as a time-weighted annual average or 10 percent, the owner or operator would be required to comply with all Subpart AA or BB requirements on the date that the facility or waste management unit becomes affected by the rules (i.e., the date the facility begins to manage wastes in the units with time-weighted annual average organic concentrations greater than 10 ppmw for Subpart AA or greater than 10 percent for Subpart BB irrespective of any change in permit status that is required by the change in waste concentration. In this situation, should the facility owner or operator elect to use a control device to comply with the process vent or equipment leak provisions, the control device must be installed and operating on the effective date; the 24-month extension beyond the promulgation date is not applicable in this case. For the process vent emission rate limit, the situation is somewhat different. TSDF process vents associated with the distillation/separation operations specified in the rule that manage wastes with time-weighted annual average organics concentrations of 10 ppmw or greater are affected by the regulation regardless of whether the facility emissions are above or below the emission rate limit. Therefore, any change in the facility operations that results in a TSDF going above or below the emission rate limit does not cause a change in the applicability of the facility to Subpart AA. The rules require that affected TSDF reduce total process vent organic emissions from all affected vents by 95 percent or reduce the facility's total process vent emissions to or below 1.4 kg/h and 2.8 Mg/yr. One of these conditions must be met at all times; the facility's emission rate determination, which documents the facility's status regarding compliance with the process vent standards, must also at all times reflect current design and operation and wastes managed in the affected units.

11.1.2 Period for LDAR

Comment: Commenters AESP-00008 and AESP-L0016 believe that the 5-day period allowed for returning a release through a pressure relief device to a "no detectable emissions" condition is too long and that the first repair of a leak should occur within 24 hours of detection. Complete repair should occur within 5 days. The standards should not retain the current requirements and still allow repair delays of up to 1 year if a process shutdown is needed. Commenter AESP-L0013 believes that any delay in repair should be conditioned by a determination that no adverse health impact would result from the delay.

Response: The selected repair intervals of the 5-day "first attempt at repair" requirement and the 15-day repair period for pumps, valves, and pressure relief devices provide maximum effectiveness of the LDAR program by requiring expeditious emission reduction, while allowing the owner or operator the time to maintain a reasonable overall maintenance schedule for the plant.

During development of the CAA standards for petroleum refineries and chemical plants (EPA-450/3-80-032a, EPA-450/3-80-033a, and EPA-450/3-82-010), EPA personnel made a concerted effort to investigate and gain knowledge of maintenance practices. In EPA's technical judgment, an initial attempt at repair within 5 days is ample for all simple field repairs. A 24-hour period following leak detection is often not long enough to allow maintenance personnel to identify the cause of the leak and then to attempt repair. Although plants could schedule repair personnel to accompany the monitoring team, emergency situations or critical equipment problems could easily upset these arrangements. Although some or most repairs can be made within 24 hours, it is not practical to require an attempt to repair all equipment within 24 hours. The EPA has not been able to distinguish between equipment that could and could not always be repaired within 24 hours. In addition, with the commenter's approach, repair crews would spend much of their time on an inspection with few needed repairs. Furthermore, the owner or operator of a recycling operation has an incentive to repair leaks as quickly as possible to prevent additional product losses.

A 15-day repair interval provides time for isolating leaking equipment for other than simple field repairs. A shorter interval could cause scheduling problems in repairing valves that are not conducive to simple field repair and that may require removal from the hazardous waste management process for repair. A 15-day interval provides the owner or operator enough time to determine precisely which spare parts are needed and to schedule repairs. In addition, a 15-day repair interval allows more efficient handling of more complex repair tasks while maintaining an effective reduction in equipment leaks. Again, the owner or operator of a recycling operation has an incentive to repair leaks promptly.

Sections 264.1059(c) and 265.1059(c) require that for delay of repair for valves to be allowed, the owner or operator must demonstrate that emissions of purged material resulting from immediate repair are greater than fugitive emissions likely to result from delay of repair and that, when repair procedures are effected, the purged material is collected and destroyed or recovered in a control device complying with Section 264.1060 or 265.1060. Therefore, the delay of repair should not result in increased emissions or health risks. Furthermore, the delay-of-repair provisions allow the facility operator sufficient time to obtain necessary repair parts and maintain some degree of flexibility in overall plant maintenance scheduling.

11.2 PERMITS

11.2.1 State and Local Role

Comment: Commenter AESP-00009 asks if EPA has analyzed the feasibility of obtaining State and local operating permits for the incinerators and flares proposed as control devices. According to the commenter, State and local governments may define organic incinerators as hazardous waste incinerators and regulate them to a 99.99-percent destruction or prohibit them completely through State and local siting procedures.

Response: Although flares and incinerators were evaluated as control devices and are approved alternatives, the standards do not require them. The EPA acknowledges that an incinerator, cement kiln, or industrial boiler accepting a RCRA-listed waste would be regulated to a 99.99-percent destruction and removal efficiency under permitting standards. Where facilities do have permitted incinerators, ducting emissions to these units is acceptable under the standards and may be more cost-effective depending on site-specific conditions. No analysis has been conducted on the feasibility, costs, or impacts of obtaining State and local operating permits for these control devices (flares and incinerators) because they are not required by the standards.

It is also important to note that noncontainerized gases emitted from hazardous wastes are not themselves hazardous wastes because the statute implicitly excludes them. EPA does, however, have the authority to regulate them as emissions from hazardous wastes. Therefore, thermal destruction of process vent emissions would not necessarily be classified as hazardous waste incineration.

11.2.2 Part B Information Requirements

Comment: Commenter AESP-00035 recommends that Section 270.22 for specific Part B information requirements should be limited to the units already included in the Part B permit application. Units that must comply with this regulation because the facility is subject to RCRA permit requirements for other reasons should not be required to be added to the Part B permit. The call for documentation of compliance with this regulation should not delay issuance of a RCRA permit.

Response: First, it should be noted that in the final standards, Part B information requirements for process vents are contained in Section 270.24 and those for equipment are in Section 270.25. The EPA is aware that extending specific Part B information requirements to those hazardous waste management units that are not subject to RCRA permitting but are located at facilities that are otherwise subject to RCRA permit requirements could result in the need for those facilities to modify RCRA permits or their Part B applications. However, EPA believes that extending the Part B information requirements to hazardous waste management units not subject to RCRA permitting is necessary to ensure compliance with the Subpart AA and Subpart BB standards.

The EPA also agrees that requiring a modification of RCRA permits (and Part B applications) as part of this rule could result in delays in processing and issuing final RCRA permits. Therefore, in the final rules, facilities are not required as a result of the TSDF process vent and equipment-leak standards to modify permits issued before the effective date. Consistent with Section 270.4, a facility with a final permit issued prior to the effective date is required to add or incorporate the requirements of these standards into their permit at permit review under Section 270.50 or reissue under Section 124.15.

Facilities that have obtained RCRA interim status, as specified in Section 270.70 (i.e., compliance with the requirements of Section 3010(a) of RCRA pertaining to notification of hazardous waste activity and the requirements of Section 270.10 governing submission of Part A applications), will be subject to the Part 265 standards on the effective date. Interium-status facilities that have submitted their Part B application prior to the effective date of the regulation will be required to modify their Part B application to incorporate the requirements of these air rules.

A facility operating under interim status that has not submitted a Part B application prior to the effective date of the regulation must incorporate the requirements of these standards in the Part B application.

11.3 COMPLIANCE PROVISIONS

11.3.1 Documentation

Comment: Commenter AESP-00034 suggests that requirements for documentation of compliance with Section 61.242-11 should not reference "Control of Gaseous Air Pollutants"; this should be replaced with engineering evaluation, a material balance calculation, or an air emission source test for the control efficiency requirement so as not to limit documentation of compliance to one publication. Commenter AESP-00034 states that Section 61.242-11 for documentation of compliance should require a compliance test instead of design criteria because the technical requirements in this section are for flares, and the documentation requirements are actually for the control efficiency requirements for control devices that are not flares.

Response: First, it should be noted that Section 61.242-11 has been incorporated into the standards as Sections 264.1060 and 265.1060. The document in question establishes review protocol for engineering design and evaluation. The promulgated regulation has been revised to allow other engineering texts acceptable to the Regional Administrator that present basic design information. In addition, specific operating parameters that must be addressed in the control device design have been added for each type of applicable control device, including flares. Also, the owner or operator must certify in writing that the control device meets the requirements of the standards. The EPA also notes that documentation demonstrating compliance with the process vent standards can be based on engineering calculations or source tests that must be made with the process operations (e.g., distillation, fractionation, or steam stripping operations) running at full operating conditions and at maximum flow rates.

11.3.2 Special Requirements

Comment: Commenter AESP-00035 recommends that Section 270.22 for "special requirements" be revised to allow equipment (e.g., piping system to incinerator) determined to be in VHAP service also to be used for non-VHAP waste transport. The commenter states that engineering judgment should be considered in revisions of the VHAP determination and the procedures specified in the section at issue should be allowed in a valid determination revision. Commenter AESP-00003 agrees in theory in that Section 269.34(a)(3) should not be included in the standards because this provision ignores the possibility of revisions that would reduce VHAP concentrations sufficiently that engineering judgment would be appropriate and because EPA retains the authority to require the procedures specified in Section 269.34(a)(1) in the event of a disagreement.

Response: First it should be noted that for clarification, "in VHAP service" has been dropped from the standards and applicability is defined strictly by the characteristics of the hazardous waste contained or contacted by equipment. Under the standards, once equipment is determined to be subject to the requirements, the equipment retains this status. Only when the operator determines that the equipment never will contain or contact a hazardous waste with 10 percent or more organics can that determination change. The purpose of this provision is to discourage switching back and forth between being subject to and not being subject to the standard requirements; with this approach, compliance would be much more straightforward and would avoid possible confusion that might lead to contravention of the standards. Equipment designated as containing or contacting hazardous waste with at least 10 percent organics can transport hazardous waste streams with less than 10 percent organics but the controls required by the standards must be maintained.

11.3.3 Alternative Means of Emission Limitation

Comment: Commenter AESP-00035 recommends that alternative means of emission limitation be allowed for permitted and interim-status facilities under Sections 269.32 and 269.33 to encourage the development of new control methods.

Response: The provisions of 40 CFR 61.244 Subpart V, which provide a formal mechanism for applying for use of an alternative means of emission limitation, were specifically not included in the proposed TSDF process vent and equipment leak rules and have not been included in the final standards. The equipment leak standards comprise the use of control equipment, inspection of process equipment, and repair programs. The alternative means of emission limitation provisions for the equipment leak standards are not considered self-implementing; i.e., these provisions cannot be satisfied without the need for detailed explanation or negotiation between the facility owner/operator and EPA. Therefore, the standards do not allow for the use of alternative means of emission limitation for equipment leaks.

The closed-vent system and control device provisions are performance standards, requiring 95 percent emission reduction or control of facility process vent emissions below the emission rate limit. Compliance with these provisions can be demonstrated and documented through the use of a performance test or engineering calculations. The standards allow an owner/operator to use a control device other than a thermal vapor incinerator, catalytic vapor incinerator, flare, boiler, process heater, condenser, or carbon adsorption system provided that documentation is developed describing control device operation and demonstrating performance. The negotiation process associated with issuance of a final permit can be used by the owner/operator and EPA to review and establish the appropriate recordkeeping requirements.

11.4 RECORDKEEPING AND REPORTING

11.4.1 Frequency of Reports

Comment: Commenter AESP-L0001 contends that a reporting frequency of 6 months is unnecessary. According to the commenter, simple certification of compliance with the standards, with records available for inspection at the respective sites, should be adequate. Commenter AESP-L0001 proposes a three-tiered approach to reporting requirements for LDAR. Specifically, semiannual reports should be required for processes with high leak rates and with records of quarterly and monthly maintenance at the plants. The reporting philosophy is similar to that used for spill prevention plans under the CWA, where reporting is not required for exceptional sites as long as records are maintained, or where reporting increases with the frequency of spills. This approach should be applied to processes with (1) leak rates of less than 2 percent, and (2) the best design features or exceptionally low emission rates. Plants using the skip period approach under 40 CFR 61.243-2 should report only annually.

Response: In the promulgated rules, reporting on a routine basis is only required for exceedance situations for facilities with final RCRA permits; there are no reporting requirements for interim-status facilities. For equipment leaks, these would be cases where leaks have not been repaired in the required time. However, if a facility does not have any exceedances during the reporting period, no report is required. Interim-status facilities also are not required to submit reports. The purposes of the reporting requirements for permitted facilities are to alert EPA offices of situations in which leaks have not been repaired as required and to assist the enforcement program to prioritize inspection and enforcement actions. Most of the detailed information on LDAR compliance is maintained at the plant site for inspection. This level of recordkeeping and reporting is the minimum level needed for enforcement and compliance purposes, and previous experience with similar regulations has shown that the reporting requirements do not create an unreasonable burden.

11.4.2 Duplication of Reports

Comment: Commenter AESP-00003 commends EPA on its efforts to eliminate duplicative recordkeeping requirements and suggests that such a provision also be included in Section 269.32 of the proposed rule.

Response: The EPA agrees that any duplicative recordkeeping and reporting should generally be eliminated to the extent possible. Because of the difficulties in foreseeing all situations in which duplication could occur, a provision to this effect has not been added to the standards. However, when records and reports required by State programs are substantially similar to those required by these standards, a copy to EPA of the information submitted to the State will generally suffice. When similar records and reports are required by other EPA programs (e.g., the visual observations required for pumps and valves associated with storage tanks and incinerators), EPA suggests that one set of records be maintained, with emphasis on the more detailed monitoring records required by these standards. The EPA considers that the monitoring required for equipment leaks under these standards differs significantly from the monitoring required for ground-water protection purposes under other RCRA rules. However, the monitoring programs and records for the air and ground-water programs can be combined to reduce labor and costs in situations where duplication exists.

11.4.3 Notification

Comment: Commenter AESP-L0015 asks whether TSDF are subject to any notification requirements if they determine that their waste stream is less than 10-percent VHAP by weight.

Response: The proposed standards, through incorporation of the provisions of 40 CFR Part 61 Subpart V, required the owner or operator of any piece of equipment to which Subpart V applied to submit a written statement to the Administrator that the requirements of the standards were being implemented. Such a notification is a normal requirement of CAA regulations. However, upon reviewing the standards within the RCRA regulatory framework, EPA determined that the notification is not needed. Enforcement of standards under RCRA is primarily through inspections during site visits, particularly the review of records maintained in the facility operating record. The semiannual exceedance reports required of permitted facilities by the standards can be used to direct enforcement efforts toward facilities with potential compliance problems. Therefore, there are no notification requirements in these rules for equipment or process vents, whether or not they manage wastes with organic concentrations above the applicability criteria. States may require such notification, however. Facilities found to have process vents and equipment that are subject to the standards and are not in compliance with the requirements of the standards will be subject to enforcement orders.

11.5 IMPLEMENTATION AND ENFORCEMENT

11.5.1 Guidance on the 95-Percent Limit

Comment: Commenter AESP-00022 states that, although the proposed rule identifies a 95-percent control for tanks and provides a method to be used to demonstrate compliance, no guidance is provided regarding whether the 95-percent is an average or instantaneous value and what time period should be used for averaging. If the figure is an average, the minimum could be achieved by scheduled maintenance and idle time shutdowns during the averaging period to limit the time the tank vents are controlled by wet scrubbers. A properly set averaging time would provide operator flexibility to control emissions without investing in equipment for short-duration shutdowns; guidance should be provided to clarify the 95-percent goal. The commenter is referring to hazardous waste storage tanks vented to an incinerator that employ wet scrubbers when the incinerator is not operating.

Response: It should be noted that, unless process emissions are vented through the hazardous waste storage tanks, the storage tank emissions are not subject to the requirements of this rulemaking. Nonetheless, in response to the commenter's concerns, the 95-percent emission control requirement is considered a continuous requirement and as such must be achieved at all times during operation of the process being vented to the atmosphere. The control technologies that are typically used for process vent emissions (condensers and carbon adsorbers) are capable of achieving the 95-percent control over extended periods if properly designed, operated, and maintained. The EPA has not identified any situations particular to this industry that would warrant any short-term variance to the 95-percent control requirement. Although there are likely to be normal variations in process stream flow rates, it is not expected that these will result in extreme emission fluctuations that could result in short-term failure to meet the 95-percent emission reduction requirement.

To ensure that the control devices perform according to design and are properly operated and maintained on a day-to-day basis, the final rules require the continuous monitoring of specific parameters on all control devices needed to meet the standards. In general, the monitoring requirements for control device operating parameters include (1) coolant fluid temperature and exit gas temperature or the concentration level of the organic compounds in the exhaust vent stream for condensers, (2) exhaust vent stream concentration level of organics or a parameter that demonstrates regularly scheduled carbon bed regeneration for carbon adsorbers, (3) combustion temperature for incinerators and other enclosed combustion devices, and (4) pilot flame detection for flares. The monitoring readings must be checked at least once each operating day and, if necessary, corrective measures must be implemented immediately to ensure that the control device operates efficiently. The monitoring information/data must also be recorded in the facility operating record. Periods when monitoring indicates control device operating parameters are outside or exceed established tolerances on design specifications that are not corrected within 24 hours must be recorded. For facilities with final RCRA permits, exceedances must be reported to the Regional Administrator on a semiannual basis; there are no reporting requirements for interim-status facilities. The records and reports must include exceedance dates, duration, cause, and corrective measures taken.

The facility process vent emission rate limit that has been added to the standards provides operators of facilities for which process vent emissions can be controlled to less than 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr) the flexibility of determining the compliance method. For example, if a WSTF has multiple process vents and total facility process vent emissions of 15 Mg/yr (16.5 ton/yr), the facility emission rate limit conceivably could be met by reducing the emissions from each vent by 82 percent (2.8 Mg/yr [3.1 ton/yr] is approximately 18 percent of 15 Mg/yr [16.5 ton/yr]) or by reducing the emissions from one vent by 95 percent if that vent accounts for 85 percent or more of the total facility process vent emissions. Detailed implementation information is provided in the guidance document that is being published concurrently with these standards.

11.5.2 Omnibus Permitting

Comment: Commenters AESP-L0016 and AESP-L0018 object to statements in the preamble regarding the role of omnibus permitting authority under RCRA Section 3005(c)(3). Commenters AESP-L0018 and AESP-L0015 question the absence of criteria for when such authority would be applied to require more stringent controls for individual constituents that continue to pose a risk after control. Commenter AESP-L0018 also does not support the use of this authority to pursue data gathering through ambient monitoring. In support, Commenter AESP-L0018 argues that data gathering does not meet the protection of human health and environment mandate of Section 3005(c). Commenter AESP-L0016 objects because the standards are not protective in all cases. Commenter AESP-L0016 also contends that Congress intended the authority of this section to be used as a temporary tool, pending promulgation of regulations providing needed protection. The commenter argues that authorizing permit writers to impose more stringent controls based on an unenforceable guidance document is not a substitute for the regulations. The commenter submits that it was precisely because hazardous air emissions at TSDF have largely been unregulated through the RCRA permit system, and because EPA had failed to promulgate permit standards under Section 3005 governing air emissions at TSDF, that Congress enacted Section 3004(n).

Response: Air emissions from hazardous wastes include photochemically reactive and nonphotochemically reactive organics, some of which are toxic or carcinogenic, and also may include toxic or carcinogenic inorganic compounds. Depending on the source, particulates (including metals, aerosols of organics, dust, as well as toxics and carcinogens) also may be released or generated. These emissions, which are released to the atmosphere from a wide variety of sources within TSDF, present diverse health and environmental risks. Therefore, EPA has developed a multiphased approach for regulating TSDF organic air emissions. This approach, described generally below, reflects the Agency's understanding of the problem and knowledge of applicable, effective controls at this time.

Organic emissions from TSDF managing hazardous wastes contribute to ambient ozone formation and increase cancer and other health risks. Phases I and II will address these two problem areas (i.e., air toxics and carcinogens, and ozone precursors) by controlling emissions of organics as a class rather than controlling emissions of individual waste constituents. The regulation of organics as a class has the advantage of being relatively straightforward because it can be accomplished with the minimum number of standards, whereas the control of individual toxic constituents will require multiple standards. Regulating organics as a class also makes efficient use of EPA resources, avoids many of the complexities of having multiple standards, and reduces the number of constituents for which separate standards ultimately will be required. The environmental effects of ambient ozone are well documented and, in terms of monetary losses, they total hundreds of millions of dollars each year. The substantial reductions in organic emissions achievable through implementation of Phase I and Phase II controls will reduce atmospheric ozone formation as a result of reductions in TSDF emissions of ozone precursors and will reduce nationwide cancer incidence and maximum individual risk due to exposure to air toxics and carcinogens emitted from TSDF.

Specifically, Phase I entails the promulgation of standards for the control of organic air emissions from selected hazardous waste management processes and equipment leaks. The EPA chose to develop this portion of its TSDF rulemaking first to prevent uncontrolled air emissions from land disposal restriction (LDR) treatment technologies. The technologies used in lieu of land disposal include the distillation/separation processes subject to the Phase I rules. Publication of the final rules for air emissions from hazardous waste management process vents from distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping processes and from leaks in piping and associated equipment handling hazardous wastes marks the completion of this first phase.

In the second phase, EPA will propose to extend standards (in mid-1990) under Section 3004(n) to include organic air emissions from other significant TSDF air emission sources not covered or not adequately controlled by existing standards. These sources include surface impoundments, storage or treatment tanks (including process vents on closed, vented tanks), containers, and miscellaneous units.

The analyses of impacts indicate that at some facilities, residual cancer risk to the most exposed individuals after implementing the first two phases of regulation will remain outside the historical range achieved by other RCRA regulations (i.e., 1×10^{-4} to 1×10^{-7}). The EPA is therefore planning a third phase of the effort to control TSDF emissions in which various means for further reducing risk will be examined. In the interim, the omnibus permitting authority of RCRA is an available option for requiring additional emission and risk reductions beyond that achieved by today's final rules if it is decided, on a case-by-case basis, that additional control is needed to protect human health and the environment.

The EPA is currently involved in an effort to improve the data used in the current risk analyses and, in the third phase, will make use of any new data obtained. If additional constituent control is found necessary, the number of constituents for which additional control is needed is expected to be significantly less than if a constituent approach were used as the only means of regulating TSDF air emissions. Therefore, the EPA is convinced that the control of organics as a class followed by controls for individual toxic constituents, if necessary, will ultimately result in comprehensive standards that are protective while providing effective interim control.

As noted above, permit writers can use their omnibus permitting authority to require more stringent controls at facilities where a high residual risk remains after implementation of the standards for volatile organics. The permitting authority cited by Section 3005 of RCRA and codified in Section 270.32(b)(2) states that permits issued under this section "...shall contain such terms and conditions as the Administrator or State Director determines necessary to protect human health and the environment." This section, in effect, allows permit writers to require, on a case-by-case basis, emission controls that are more stringent than those specified by a standard. The EPA has a mandate to use this authority for situations in which regulations have not been developed or in which special requirements are needed to protect human health and the environment. For example, this authority can be used in situations where, in the permit writer's judgment, there is an unacceptably high residual risk after application of controls required by the process vent and equipment organic emission standards.

The EPA is currently preparing guidance to be used by permit writers to help identify facilities that would potentially have high residual risk. The guidance will include procedures to be used to identify potentially high-risk facilities and will include guidance for making a formal, site-specific risk assessment. Methods for providing additional emissions control at facilities identified as having high residual risk after implementation of the standards for volatile organics will be included in additional guidance developed by the Agency. Examples of both risk assessments and the provision of additional emissions control will be included in the respective guidance documents.

As has been described above, the approach that EPA is using to control TSDF air emissions is to proceed with promulgation of regulations to control organic emissions (Phases I and II) and to follow this with a phase of regulations that would require more stringent controls for individual hazardous constituents where necessary. With regard to data-gathering by ambient air quality monitoring, the feasibility of requiring site-specific risk analyses that involve the determination of ambient air quality impacts through dispersion modeling or ambient monitoring for TSDF is currently being studied under the Phase II and III standards and will not be required for the purposes of these standards.

11.5.3 State and Regional Role

Comment: Commenters AESP-00031, AESP-00032, and AESP-L0015 ask that EPA clearly delineate whether implementation and enforcement responsibilities are under the CAA or RCRA.

Response: Implementation and enforcement responsibilities for these TSDF air rules will be under RCRA. Although EPA acknowledges that CAA offices have been active in permitting decisions and have experience and expertise in air concerns, RCRA personnel must implement and enforce RCRA rules. Internally, EPA will delineate how these offices can work together to eliminate duplication of permitting and enforcement labor. To this end, EPA has developed an Implementation Work Group to discuss these and similar concerns. An implementation guidance document is being issued in conjunction with promulgation of these TSDF air rules.

11.5.4 LDAR Enforcement Approach

Comment: Commenter AESP-00021 recommends that EPA adopt the LDAR enforcement approach used in California where, if a leak has not been recorded or repaired within a specified timeframe, then the leak is a violation. In the alternative, EPA could define as a violation any leak found by an inspector that has not been recorded or repaired properly after a company inspection. These approaches give the control authority some recourse if the facility is not conducting the program properly or not conducting it at all.

Response: Seals and packings inherently leak and not even the use of leakless equipment can prevent occasional leakage. Because an occasional leak cannot be prevented, EPA cannot accept the commenter's suggestion that a leak (a reading over 10,000 ppm) should be considered a violation when documented during a compliance inspection. Instead, the compliance burden has been placed on the owner or operator to attempt to repair the leak within 5 days of its detection and to completely repair the leak within 15 days.

The commenter implies that enforcement is unlikely because it must be proven that recordkeeping and reporting requirements were not met or that the leaking component was not repaired. The EPA disagrees. The regulation states that compliance will be determined by review of records, reports, performance test results, and inspections. By comparing records and reports of plant performance to the actual sources during an onsite inspection, enforcement personnel will be able to detect unrepaired sources, unsubstantiated records regarding delayed repair, falsified records, and lack of records or reports. Under these standards, the records and reports (or lack thereof) provide usable evidence of a violation, and enforcement action is likely. Although the recordkeeping and reporting requirements, coupled with onsite inspections, are the only measures to determine compliance, EPA believes these provisions are adequate to ensure diligent monitoring and repair of leaks by plant personnel and effective enforcement by EPA.

11.6 MISCELLANEOUS

Comment: Commenter AESP-00001, a private citizen from Strasburg, Virginia, does not address the specific proposal, but describes instead the health problems for area residents exposed to organics emissions caused by a printing company located near his home. He also describes the difficulties in working with company and government officials.

Response: The EPA is concerned about the health problems associated with air toxics contained in the organic emissions subject to control by these standards. These emissions can cause short-term and acute health problems. Although the company in question may not be subject to these RCRA standards unless it has certain processes onsite for hazardous waste treatment, existing standards under the CAA would likely apply to this site.

APPENDIX A

EVOLUTION OF PROMULGATED STANDARDS

TABLE A-1. EVOLUTION OF THE FINAL RULES

Date	Event
February 5, 1987	Publication of proposed rules in the Federal Register, 52 FR 3748.
March 23, 1987	Public hearing regarding the proposed rules.
September, 1987	Information requests, as authorized under Section 3007 of RCRA sent to select TSDF.
August 4, 1988	Work Group Closure meeting on final TSDF process vent and equipment leaks standards (#1). Closure not reached.
April 3, 1989	Work Group Closure meeting on final TSDF process vent and equipment leak standards (#2). Closure reached.
June 13, 1990	Final rules signed by EPA Administrator.

APPENDIX B

ESTIMATING HEALTH IMPACTS

APPENDIX B

ESTIMATING HEALTH IMPACTS

Many adverse health effects can result from exposure to air emissions from hazardous waste treatment, storage, and disposal facilities (TSDF). The major pathways for human exposure to environmental contaminants are through inhalation, ingestion, or dermal contact. Airborne contaminants may be toxic to the sites of immediate exposure, such as the skin, eyes, and linings of the respiratory tract. Toxicants may also cause a spectrum of systemic effects following absorption and distribution to various target sites such as the liver, kidneys, and central nervous system.

Exposure to contaminants in air can be acute, subchronic, or chronic. Acute exposure refers to a very short-term (i.e., ≤24 h), usually single-dose, exposure to a contaminant. Health effects often associated with acute exposure include: central nervous system effects such as headaches, drowsiness, anesthesia, tremors, and convulsions; skin, eye, and respiratory tract irritation; nausea; and olfactory effects such as awareness of unpleasant or disagreeable odors. Many of these effects are reversible and disappear with cessation of exposure. Acute exposure to very high concentrations or to low levels of highly toxic substances can, however, cause serious and irreversible tissue damage, and even death. A delayed toxic response may also occur following acute exposure to certain agents.

Chronic exposures are those that occur for long periods of time (from many months to several years). Subchronic exposure falls between acute and chronic exposure, and usually involves exposure for a period of weeks or months. Generally, the health effects of greatest concern following intermittent or continuous long-term exposures are those that cause either irreversible damage and serious impairment to the normal functioning of the individual, such as cancer and organ dysfunctions, or death.

The risk associated with exposure to a toxic agent is a function of many factors, including the physical and chemical characteristics of the substance, the nature of the toxic response and the dose required to produce the effect, the susceptibility of the exposed individual, and the exposure situation. In many cases, individuals may be concurrently or sequentially exposed to a mixture of compounds, which may influence the risk by changing the nature and magnitude of the toxic response.

B.1 ESTIMATION OF CANCER POTENCY

The unit risk estimate (URE, unit risk factor) is used by the Environmental Protection Agency (EPA) in its analysis of carcinogens. It is defined as the lifetime cancer risk occurring in a hypothetical population in which all individuals are exposed throughout their lifetime (assumed to be 70 years) to an average concentration of 1 $\mu g/m^3$ of the pollutant in the air they breathe. Unit risk estimates can be used for two purposes: (1) to compare the carcinogenic potency of several agents with one another, and (2) to give a rough indication of the public health risk that might be associated with estimated air exposure to these agents.[1]

In the development of unit risk estimates, EPA assumes that if experimental data show that a substance is carcinogenic in animals, it may also be carcinogenic in humans. The EPA also assumes that any exposure to a carcinogenic substance poses some risk.[2] This nonthreshold presumption is based on the view that as little as one molecule of a carcinogenic substance may be sufficient to transform a normal cell into a cancer cell. Exposed individuals are represented by a referent male having a standard weight, breathing rate, etc. (no reference is made to factors such as race or state of health).

The data used for the quantitative estimate can be of two types: (1) lifetime animal studies, and (2) human studies where excess cancer risk has been associated with exposure to the agent. It is assumed, unless evidence exists to the contrary, that if a carcinogenic response occurs at the dose levels used in a study, then responses will occur at all lower doses with an incidence determined by the extrapolation model.

There is no solid scientific basis for any mathematical extrapolation model that relates carcinogen exposure to cancer risks at the extremely low concentrations that must be dealt with in evaluating environmental hazards.

For practical reasons, such low levels of risk cannot be measured directly either by animal experiments or by epidemiologic studies. We must, therefore, depend on our current understanding of the mechanisms of carcinogenesis for guidance as to which risk model to use. At present, the dominant view of the carcinogenic process is that most agents that cause cancer also cause irreversible damage to DNA. This position is reflected by the fact that a very large proportion of agents that cause cancer are also mutagenic. There is reason to expect that the quantal type of biological response, which is characteristic of mutagenesis, is associated with a linear nonthreshold dose-response relationship. Indeed, there is substantial evidence from mutagenesis studies with both ionizing radiation and a wide variety of chemicals that this type of dose-response model is the appropriate one to use. This is particularly true at the lower end of the dose-response curve. At higher doses, there can be an upward curvature probably reflecting the effects of multistage processes on the mutagenic response. The linear nonthreshold dose-response relationship is also consistent with the relatively few epidemiologic studies of cancer responses to specific agents that contain enough information to make the evaluation possible (e.g., radiation-induced leukemia, breast and thyroid cancer, skin cancer induced by arsenic in drinking water, liver cancer induced by aflatoxins in the diet). There is also some evidence from animal experiments that is consistent with the linear nonthreshold model (e.g., liver tumors induced in mice by 2-acetylaminofluorene in the large-scale ED_{01} study at the National Center for Toxicological Research and the initiation stage of the two-stage carcinogenesis model in rat liver and mouse skin).

Because of this evidence, the linear nonthreshold model is considered to be a viable model for any carcinogen, and unless there is direct evidence to the contrary, it is used as the primary basis for risk extrapolation to low levels of exposure.[3]

The mathematical formulation chosen to describe the linear nonthreshold dose-response relationship at low doses is the linearized multistage model. The linearized multistage model is applied to the original unadjusted animal data. Risk estimates produced by this model from the animal data are then scaled to a human equivalent estimate of risk. This is done by multiplying the estimates by several factors to adjust for experiment duration, species differences, and, if necessary, route conversion. The conversion factor for species differences is currently based on models for equitoxic dose.[4] The unit risk values estimated by this method provide a plausible, upperbound limit on public risk at lower exposure levels if the exposure is accurately quantified; i.e., the true risk is unlikely to be higher than the calculated level and could be substantially lower.

The method that has been used in most of the EPA's quantitative risk assessments assumes dose equivalence in units of mg/body weight$^{2/3}$ for equal tumor response in rats and humans. This method is based on adjustment for metabolic differences. It assumes that metabolic rate is roughly proportional to body surface areas and that surface area is proportional to 2/3 power of body weight (as would be the case for a perfect sphere). The estimate is also adjusted for lifetime exposure to the carcinogen considering duration of experiment and animal lifetime.[5,6]

For unit risk estimates for air, animal studies using exposure by inhalation are preferred. When extrapolating results from the inhalation studies to humans, consideration is given to the following factors:

- The deposition of the inhaled compound throughout the respiratory tract
- Retention half-time of the inhaled particles
- Metabolism of the inhaled compound
- Differences in sites of tumor induction.

Unit risk estimation from animal studies is only an approximate indication of the actual risk in populations exposed to known concentrations of a carcinogen. Differences between species (lifespan, body size, metabolism, immunological responses, target site susceptibility), as well as differences within species (genetic variation, disease state, diet), can cause actual risk to be much different. In human populations, variations occur in genetic constitution, diet, living environment, and activity patterns. Some populations may demonstrate a higher susceptibility due to certain metabolic or inherent differences in their response to the effects of carcinogens. Also, unit risk estimates are based on exposure to a referent adult male. There may be an increased risk with exposure to fetuses, children, or young adults. Finally, humans are exposed to a variety of compounds, and the health effects, either synergistic, additive, or antagonistic, of exposure to complex mixtures of chemicals are not known.[7,8]

B.1.1 EPA Unit Risk Estimates

The EPA has developed unit risk estimates for about 71 compounds that are either known or suspect carcinogens and that could be present at a TSDF (Table B-1). Constituents were drawn from the Agency's final rule on the identification and listing of hazardous waste (Appendix VIII)[9] and from the Industry Studies Data Base, a hazardous waste data base developed by EPA's Office of Solid Waste.[10] The unit risk estimates in Table B-1 have been derived by the Agency's Carcinogen Assessment Group,[11] and most have been verified by the Agency's Carcinogen Risk Assessment Verification Enterprise (CRAVE) or are under CRAVE review. As shown in Table B-1, these estimates range in value from 4.7×10^{-7} $(\mu g/m^3)^{-1}$ for methylene chloride to 3.3×10^{-5} $(pg/m^3)^{-1}$ for dioxin.

B.1.2 Composite Unit Risk Estimate

To estimate the cancer potency of TSDF air emissions, a composite unit risk estimate approach was adopted to address the problem of dealing with the large number of toxic chemicals that are present at TSDF. Using a composite estimate rather than individual unit risk estimates simplifies the risk assessment so that calculations do not need to be performed for each chemical emitted. The composite risk estimate is combined with estimates of ambient concentrations of total organics and population exposure to estimate the additional cancer incidence in the general population and the maximum individual risk due to TSDF emissions.

Because detailed equipment leak emission estimates are available and because cancer incidence and maximum individual risk are proportional to both the unit risk estimates and emissions, an emission-weighted averaging technique was used. In calculating the emission-weighted average, the emission estimate for a compound is multiplied by the unit risk estimate for that compound. The emission-weighted arithmetic average is computed as follows:

TABLE B-1. TSDF CARCINOGEN LIST

	Constituent	Unit risk estimate $(\mu g/m^3)^{-1}$	Basis[a]
1.	acetaldehyde (75-07-0)	$2.2x10^{-6}$	CRAVE verified (class B2)
2.	acrylamide (79-06-1)	$1.1x10^{-3}$	CAG URE (class B2)
3.	acrylonitrile (107-13-1)	$6.8x10^{-5}$	CRAVE verified URE (class B1)
4.	aldrin (309-00-2)	$4.9x10^{-3}$	CRAVE verified URE (class B2)
5.	aniline (62-53-3)	$7.4x10^{-6}$	CAG URE (class C)
6.	arsenic (7440-38-2)	$4.3x10^{-3}$	CRAVE verified (class A)
7.	benz(a)anthracene (56-55-3)	$8.9x10^{-4}$	CAG URE (class B2)
8.	benzene (71-43-2)	$8.3x10^{-6}$	CRAVE verified (class A)
9.	benzidine (92-87-5)	$6.7x10^{-2}$	CRAVE verified URE (class A)
10.	benzo(a)pyrene (50-32-8)	$1.7x10^{-3}$	CAG URE (class B2)
11.	beryllium (7440-41-7)	$2.4x10^{-3}$	CAG URE (class B2)
12.	bis(chloroethyl) ether (111-44-4)	$3.3x10^{-4}$	CRAVE verified URE (class B2)
13.	bis(chloromethyl) ether (542-88-1)	$2.7x10^{-3}$	CAG URE (class A)
14.	1,3-butadiene (106-99-0)	$2.8x10^{-4}$	CRAVE verified URE (class B2)
15.	cadmium (7440-43-9)	$1.8x10^{-3}$	CRAVE verified URE (class B1)

(continued)

TABLE B-1 (continued)

	Constituent	Unit risk estimate, $(\mu g/m^3)^{-1}$	Basis[a]
16.	carbon tetrachloride (56-23-5)	$1.5x10^{-5}$	CRAVE verified URE (class B2)
17.	chlordane (12789-03-6)	$3.7x10^{-4}$	CRAVE verified URE (class B2)
18.	chloroform (67-66-3)	$2.3x10^{-5}$	CRAVE verified (class B2)
19.	chloromethane (74-87-3)	$3.6x10^{-6}$	ECAO URE (class C)
20.	chloromethyl methyl ether (107-30-2)	$2.7x10^{-3}$	CAG URE (class A)
21.	chromium VI (7440-47-3)	$1.2x10^{-2}$	CRAVE verified URE (class A)
22.	DDT (50-29-3)	$9.7x10^{-5}$	CRAVE verified URE (class B2)
23.	dibenz(a,h) anthracene (53-70-3)	$1.4x10^{-2}$	CAG URE (class B2)
24.	1,2-dibromo-3-chloropropane (96-12-8)	$6.3x10^{-3}$	CAG URE (class B2)
25.	1,2-dichloroethane (107-06-2)	$2.6x10^{-5}$	CRAVE verified URE (class B2)
26.	1,1-dichloroethylene (75-35-4)	$5.0x10^{-5}$	CRAVE verified URE (class C)
27.	dieldrin (60-57-1)	$4.6x10^{-3}$	CRAVE verified URE (class B2)
28.	2,4-dinitrotoluene (121-14-2)	$8.8x10^{-5}$	CAG URE (class B2)

(continued)

TABLE B-1 (continued)

	Constituent	Unit risk estimate $(\mu g/m^3)^{-1}$	Basis[a]
29.	1,4-dioxane (123-91-1)	1.4×10^{-6}	CAG URE (class B2)
30.	1,2-diphenylhydrazine (122-66-7)	2.2×10^{-4}	CRAVE verified (class B2)
31.	epichlorohydrin (106-89-8)	1.2×10^{-6}	CRAVE verified URE (class B2)
32.	ethylene dibromide (106-93-4)	2.2×10^{-4}	CRAVE verified URE (class B2)
33.	ethylene oxide (75-21-8)	1.0×10^{-4}	CAG URE (class B1-B2)
34.	formaldehyde (50-00-0)	1.3×10^{-5}	CAG URE (class B1)
35.	gasoline (8006-61-9)	6.6×10^{-7}	CAG URE (class B2)
36.	heptachlor (76-44-8)	1.3×10^{-3}	CRAVE verified URE (class B2)
37.	heptachlor epoxide (1024-57-3)	2.6×10^{-3}	CRAVE verified URE (class B2)
38.	hexachlorobenzene (118-74-1)	4.9×10^{-4}	CAG URE (class B2)
39.	hexachlorobutadiene (87-68-3)	2.2×10^{-5}	CRAVE verified URE (class C)
40.	hexachlorocyclohexane (no CAS #)	5.4×10^{-4}	CRAVE verified URE (class B2)
41.	alpha-hexachlorocyclohexane (319-84-6)	1.8×10^{-3}	CRAVE verified URE (class B2)
42.	beta-hexachlorocyclohexane (319-85-7)	5.3×10^{-4}	CRAVE verified URE (class B2)

(continued)

TABLE B-1 (continued)

	Constituent	Unit risk estimate $(\mu g/m^3)^{-1}$	Basis[a]
43.	gamma-hexachlorocyclohexane (lindane)(58-89-9)	3.8×10^{-4}	CRAVE verified URE (class C)
44.	hexachlorodibenzo-p-dioxin,1:2 mixture (57653-85-7 or 19408-74-3)	1.3×10^{0}	CRAVE verified URE (class B2)
45.	hexachloroethane (67-72-1)	4.0×10^{-6}	CRAVE verified URE (class C)
46.	hydrazine (302-01-2)	2.9×10^{-3}	CAG URE (class B2)
47.	3-methylcholanthrene (56-49-5)	2.7×10^{-3}	CAG URE (class B2)
48.	4,4'-methylene-bis (2-chloroaniline) (101-14-4)	4.7×10^{-5}	CAG URE (class B2)
49.	methylene chloride (75-09-2)	4.7×10^{-7}	CAG URE UCR (class B2)
50.	methyl hydrazine (60-34-4)	3.1×10^{-4}	ECAO URE (class B2)
51.	nickel refinery dust (7440-02-0)	2.4×10^{-4}	CRAVE verified URE (class A)
52.	nickel subsulfide (12035-72-2)	4.8×10^{-4}	CRAVE verified URE (class B2)
53.	2-nitropropane (79-46-9)	2.7×10^{-3}	CAG URE (class B2)
54.	n-nitrosodi-n-butylamine (924-16-3)	1.6×10^{-3}	CRAVE verified URE (class B2)
55.	n-nitrosodiethylamine (55-18-5)	4.3×10^{-2}	CRAVE verified URE (class B2)

(continued)

TABLE B-1 (continued)

	Constituent	Unit risk estimate $(\mu g/m^3)^{-1}$	Basis[a]
56.	n-nitrosodimethylamine (62-75-9)	1.4×10^{-2}	CRAVE verified URE (class B2)
57.	n-nitroso-n-methylurea (684-93-5)	8.6×10^{-2}	CAG URE (class B2)
58.	n-nitrosopyrrolidine (930-55-2)	6.1×10^{-4}	CRAVE verified URE (class B2)
59.	pentachloronitrobenzene (82-68-8)	7.3×10^{-5}	CAG URE (class C)
60.	polychlorinated biphenyls (1336-36-3)	1.2×10^{-3}	CAG URE (class B2)
61.	pronamide (23950-58-5)	4.6×10^{-6}	CAG URE (class C)
62.	reserpine (50-55-5)	3.0×10^{-3}	CAG URE (class B2)
63.	2,3,7,8-tetrachlorodibenzo-p-dioxin (1746-01-6)	3.3×10^{-5} $(pg/m^3)^{-1}$	CAG URE (class B2)
64.	1,1,2,2-tetrachloroethane (79-34-5)	5.8×10^{-5}	CRAVE verified URE (class C)
65.	tetrachloroethylene (127-18-4)	5.8×10^{-7}	CAG URE (class B2)
66.	thiourea (62-56-6)	5.5×10^{-4}	CAG URE (class B2)
67.	toxaphene (8001-35-2)	3.2×10^{-3}	CRAVE verified URE (class B2)

(continued)

TABLE B-1 (continued)

	Constituent	Unit risk estimate, $(\mu g/m^3)^{-1}$	Basis[a]
68.	1,1,2-trichloroethane (79-00-5)	1.6×10^{-5}	CRAVE verified URE (class C)
69.	trichloroethylene (79-01-6)	1.7×10^{-6}	CAG URE (class B2)
70.	2,4,6-trichlorophenol (88-06-2)	5.7×10^{-6}	CRAVE verified URE (class B2)
71.	vinyl chloride (75-01-4)	4.1×10^{-6}	CAG URE (class A)

( ) = Chemical Abstracts Service (CAS) Number.

[a] Cancer unit risk estimates (UREs) were either (1) verified by the Carcinogen Risk Assessment Verification Enterprise (CRAVE) work group or (2) established by the Carcinogen Assessment Group (CAG), but not yet verified by CRAVE. The unit risk estimates for chloromethane and methyl hydrazine were derived by the Environmental Criteria and Assessment Office (ECAO).

Note: The constituents on this list and the corresponding unit risk estimates are subject to change.

$$\overline{RE} = \frac{\sum_{i=1}^{N} (RE_i \cdot ER_i)}{ER_t} , \qquad (B\text{-}1)$$

where

$\overline{RE}$ = weighted average unit risk estimate

RE_i = unit risk estimate for compound i

ER_i = TSDF emissions for compound i

ER_t = total emissions for TSDF.

Using this type of average would give the same result as calculating the risk for each chemical involved.

The calculation of the composite unit risk estimate for the TSDF equipment leak baseline case is illustrated in Table B-2. The table lists the compounds included in the development of the composite risk estimate, total nationwide baseline TSDF equipment leak emissions by compound, the unit risk estimate by compound, and the weighted-average unit risk estimate. The composite unit risk estimate calculated in this analysis for the baseline TSDF equipment leaks is 4.5×10^{-6} $(\mu g/m^3)^{-1}$. In the calculation of the TSDF equipment leak unit risk factor, the emissions shown in Table B-2 (i.e., 18,413 Mg/yr) represent leaks from equipment associated with hazardous waste management units other than solvent recycling units. The data base used for the analysis did not contain information on TSDF solvent recycling units or waste solvent treatment facilities. Emissions from these units were calculated separately and were estimated to be an additional 7,830 Mg/yr, bringing the total TSDF equipment leaks emission estimate to about 26,200 Mg/yr. Available data in the waste characterization data base (see Appendix D, Section D.2) were not adequate to allow recycling unit equipment leak emissions to be estimated on a constituent basis and included in the calculation. Because it is not unreasonable to assume a similar mix of constituents in recycling units as in other waste management units, and because available data do not suggest otherwise, for the purpose of estimating impacts the same unit risk factor

TABLE B-2. CALCULATION OF THE EQUIPMENT LEAK EMISSIONS-WEIGHTED COMPOSITE UNIT RISK ESTIMATE (URE) FOR THE BASELINE[a]

Compound	Baseline emissions, Mg/yr	URE[b]	URE x emissions for chemical[b] / Total TSDF emissions
Acetaldehyde	477.153	2.2E-06	5.70E-08
Acrylamide	0	1.1E-03	0.00E+00
Acrylonitrile	30.06	6.8E-05	1.11E-07
Aldrin	0.002	4.9E-03	5.32E-10
Aniline	10.514	7.4E-06	4.23E-09
Benzene	37.03	8.3E-06	1.67E-08
Benzo(a)pyrene	0.003	1.7E-03	2.77E-10
Benz(a)anthracene	0	8.9E-04	0.00E+00
bis(chloromethyl)ether	0.008	2.7E-03	1.17E-09
bis(2-chloroethyl)ether	0.001	3.3E-04	1.79E-11
Butadiene(1,3)	2.362	2.8E-04	3.59E-08
Carbon tetrachloride	118.1	1.5E-05	9.62E-08
Chlordane	0.003	3.7E-04	6.03E-11
Chloroform	128.504	2.3E-05	1.61E-07
Chloromethane	0.124	3.6E-06	2.42E-11
Chloromethyl(methyl)ether	0	2.7E-03	0.00E+00
DDT (4,4')	0.005	3.0E-04	8.15E-11
Dibenz(a,h)anthracene	0.0E+00	1.4E-02	0.00E+00
Dibromo-(1,2)-chloropropane(3)	0.003	6.3E-03	1.03E-09
Dibromoethane	0	2.2E-04	0.00E+00
Dichloroethane(1,2)	392.863	2.6E-05	5.55E-07
Dichloroethylene(1,1)(54)	1.965	5.0E-05	5.34E-09
Dinitrotoluene(2,4)	0.167	8.8E-05	7.98E-10
Dioxane(1,4)	12.065	1.4E-06	9.17E-10
Diphenylhydrazine(1,2)	0	2.2E-04	0.00E+00
Epichlorohydrin	2.884	1.2E-06	1.88E-10
Ethylene dibromide	8.703	2.2E-04	1.04E-07
Ethyleneoxide	0	1.0E-04	0.00E+00
Formaldehyde	31.61	1.3E-05	2.23E-08
Gasoline(58)	39.24	6.6E-07	1.14E-09
Heptachlor	0	1.3E-03	0.00E+00
Hexachlorobenzene	6.613	4.9E-04	1.76E-07
Hexachlorobutadiene	76.91	2.2E-05	9.19E-08
Hexachloroethane	93.93	4.0E-06	2.04E-08
Hydrazine	1.087	2.9E-03	1.71E-07
Lindane	0.0E+00	3.8E-04	0.00E+00
Methyl hydrazine	9.212	3.1E-04	1.55E-07
Methylcholanthrene(3)	0.001	2.7E-03	1.47E-10
Methylene chloride	369.974	4.7E-07	9.44E-09
Nitropropane(2)	8.878	2.7E-03	1.30E-06

(continued)

TABLE B-2 (continued)

Compound	Baseline emissions, Mg/yr	URE[b]	URE x emissions for chemical[b] / Total.TSDF emissions
N-Nitrosopyrrolidine	0	6.1E-04	0.00E+00
N-nitroso-n-methylurea	0	8.6E-02	0.00E+00
Polychlorinated biphenyls(11)	3.1E-02	1.2E-03	2.02E-09
Tetrachlorodibenzo(2,3,7,8)-p-dioxin	0.0E+00	3.3E+01	0.00E+00
Tetrachloroethane(1,1,2,2)	182.478	5.8E-05	5.75E-07
Tetrachloroethylene	334.259	5.8E-07	1.05E-08
Thiourea	8.731	5.5E-04	2.61E-07
Toxaphene	0	3.2E-03	0.00E+00
Trichloroethane(1,1,2)	483.978	1.6E-05	4.21E-07
Trichloroethylene	837.562	1.7E-06	7.73E-08
Trichlorophenol(2,4,6)	0.007	5.7E-06	2.17E-12
Vinyl chloride	7.087	4.1E-06	1.58E-09
Total nationwide baseline emissions	18,413[c]		4.5×10^{-6}

TSDF = Treatment, storage, and disposal facility.

[a] This table illustrates the calculation of the composite unit risk estimate for the baseline. This procedure was repeated for each of the control options.

[b] Units are $(\mu g/m^3)^{-1}$.

[c] The emissions shown, i.e., 18,413 Mg/yr, represent leaks from equipment associated with hazardous waste management units other than solvent recycling units. Emissions from these units were calculated separately and were estimated to be an additional 7,830 Mg/yr, bringing the total TSDF equipment leaks emission estimate to about 26,200 Mg/yr. Available data in the waste characterization data base (See Appendix D, Section D.2) were not adequate to allow recycling unit equipment leak emissions to be estimated on a constituent basis and included in the calculation.

was used for all equipment leak and recycling unit health impacts. (See Chapter 7 of the BID for further discussion of the representativeness of the waste streams.)

The unit risk factor calculation was repeated for each of the control options based on the compound-specific emission estimates associated with the option. The resulting composite unit risk estimates for control options were not significantly different from the baseline value. The emission rates of specific compounds under the various control options changed proportionally under each option.

In addition to the uncertainties in estimates of emissions, other difficulties arise in averaging the UREs for specific constituents to develop a composite URE. Unit risk estimates have not been developed for all of the pollutants of concern, due, in part, to insufficient data. Various options for dealing with this problem were considered. The EPA selected an approach in which only those carcinogens for which unit risk estimates were available would be included in the analysis of cancer risk. Consideration was also given to adding the weighted risk estimates for only those compounds having similar EPA classifications,[13] i.e., to present the composite unit risk estimate and associated cancer risks separately for Group A compounds (human carcinogens), Group B compounds (probable human carcinogens), and Group C compounds (possible human carcinogens). However, because only about 1 percent of the weighted composite risk estimate is attributed to Group A compounds and about 5 percent for Group C, EPA elected to present the risk associated with all three groups combined.

B.2 DETERMINING NONCANCER HEALTH EFFECTS

Although cancer is of great concern as an adverse health effect associated with exposure to a chemical or a mixture of chemicals, many other health effects may be associated with such exposures. These effects may range from subtle biochemical, physiological, or pathological effects to gross effects such as death. The effects of greatest concern are the ones that are irreversible and impair the normal functioning of the individual. Some of these effects include respiratory toxicity, developmental and reproductive toxicity, central nervous system effects, and other systemic effects such as liver and kidney toxicity, cardiovascular toxicity, and immunotoxicity.

B.2.1 Health Benchmark Levels

For chemicals that give rise to toxic endpoints other than cancer and gene mutations, there appears to be a level of exposure below which adverse health effects usually do not occur. This threshold-of-effect concept maintains that an organism can tolerate a range of exposures from zero to some finite value without risk of experiencing a toxic effect. Above this threshold, toxicity is observed as the organism's homeostatic, compensating, and adaptive mechanisms are overcome. To provide protection against adverse health effects in even the most sensitive individuals in a population, regulatory efforts are generally made to prevent exposures from exceeding a health "benchmark" level that is below the lowest of the thresholds of the individuals within a population.

Benchmark levels, termed reference doses (RfDs), are operationally derived from an experimentally obtained no-observed-effect level or a lowest-observed-effect level by consistent application of generally order-of-magnitude uncertainty factors that reflect various types of data used to estimate the RfD. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of daily exposure to the human population (including sensitive subpopulations) that is likely to be without an appreciable risk of deleterious effect.

The Agency has developed verified oral RfD for a large number of chemicals, but has only recently established an internal work group to begin the process for establishing inhalation RfDs. Agency-verified inhalation reference doses for acute and chronic exposures will be used in this analysis when they become available. Unverified inhalation reference doses that have been developed by the Agency may be used on an interim basis after careful review of the supporting data base.

B.2.2 Noncarcinogenic Toxic Chemicals of Concern

A preliminary list of 179 TSDF chemicals of concern for the noncancer health assessment is shown in Table B-3. Constituents were drawn from the Agency's final rule on the identification and listing of hazardous waste (Appendix VIII)[14] and from the Industry Studies Data Base, a hazardous waste data base developed by EPA's Office of Solid Waste.[15] To be selected from these sources, the chemical must have had either an Agency-verified

TABLE B-3. TSDF CHEMICALS - NONCANCER HEALTH EFFECTS ASSESSMENT

Chemical
acetone (67-64-1)
acetaldehyde[a] (75-07-0)
acetonitrile (75-05-8)
acetophenone (98-86-2)
acetyl chloride (75-36-5)
1-acetyl-2-thiourea (591-08-2)
acrolein[a] (107-02-8)
acrylic acid (79-10-7)
acrylonitrile[a] (107-13-1)
aldicarb (116-06-3)
aldrin[a] (309-00-2)
allyl alcohol (107-18-6)
allyl chloride[a] (107-05-1)
aluminum phosphide (20859-73-8)
5-aminomethyl-3-isoxazolol (2763-96-4)
4-aminopyridine (504-24-5)
ammonia (7664-41-7)
ammonium vanadate (7803-55-6)
antimony (7440-36-0)
arsenic[a] (7440-38-2)
barium (7440-39-3)
barium cyanide (542-62-1)
benzidine[a] (92-87-5)
benzoic acid (65-85-0)
beryllium[a] (7440-41-7)
1,1-biphenyl (92-52-4)
bis(2-ethylhexyl)phthalate[a] (117-81-7)
bromodichloromethane (75-27-4)
bromoform (75-25-2)
butanol (71-36-3)
cadmium[a] (7440-43-9)
calcium chromate[a] (13765-19-0)
calcium cyanide (592-01-8)
carbon disulfide (75-15-0)
carbon oxyfluoride (353-50-4)
carbon tetrachloride[a] (56-23-5)
chlordane[a] (12789-03-6)
chlorine (7782-50-5)
chloroacetaldehyde (107-20-0)
2-chloro-1,3-butadiene (126-99-8)
chloroform[a] (67-66-3)
chloromethane[a] (74-87-3)
3-chloropropionitrile (542-76-7)
chromium III (7440-47-3)
chromium VI (7440-47-3)
copper cyanide (544-92-3)
cresols[a] (1319-77-3)
crotonaldehyde (4170-30-3)
cumene (98-82-8)
cyanide (57-12-5)
cyanogen (460-19-5)
cyanogen bromide[a] (506-68-3)
cyanogen chloride (506-77-4)
cyclohexanone (108-94-1)
2,4 D (dichlorophenoxyacetic acid) (94-75-7)
DDT[a] (50-29-3)

(continued)

TABLE B-3 (continued)

Chemical
decabromodiphenyl oxide (1163-19-5)
di-n-butyl phthalate (84-74-2)
1,2-dichlorobenzene (95-50-1)
1,4-dichlorobenzene[a] (106-46-7)
dichlorodifluoromethane (75-71-8)
1,1-dichloroethane[a] (75-34-3)
1,1-dichloroethylene[a] (75-35-4)
2,4-dichlorophenol (120-83-2)
1,3-dichloropropene[a] (542-75-6)
dieldrin[a] (60-57-1)
diethyl phthalate (84-66-2)
dimethoate (60-51-5)
dimethyl amine (124-40-3)
dimethyl aniline (121-69-7)
(alpha, alpha) dimethyl phenethylamine (122-09-8)
dimethylterephthalate (120-61-6)
2,4-dinitrophenol (51-28-5)
dinoseb (88-85-7)
diphenyl amine (122-39-4)
disulfoton (298-04-4)
endosulfan (115-29-7)
endothall (129-67-9)
endrin (72-20-8)
epichlorohydrin[a] (chloro-2,3-epoxy-propane) (106-89-8)
ethyl acetate (141-78-6)
ethyl benzene (100-41-4)
ethylene glycol (107-21-1)
ethylene oxide[a] (75-21-8)
ethylene thiourea[a] (96-45-7)
fluoracetic acid, sodium salt (62-74-8)
fluoride (16984-48-8)
fluorine (7782-41-4)
formaldehyde[a] (50-00-0)
formic acid (64-18-6)
freon 113 (76-13-1)
furan (110-00-9)
gamma-hexachlorocyclohexane (lindane) (58-89-9)
heptachlor[a] (76-44-8)
heptachlor epoxide[a] (1024-57-3)
hexachlorobutadiene[a] (87-68-3)
hexachlorocyclopentadiene (77-47-4)
hexachloroethane[a] (67-72-1)
hydrogen chloride (7647-01-0)
hydrogen cyanide (74-90-8)
hydrogen sulfide (7783-06-4)
isobutyl alcohol (78-83-1)
lead (7439-92-1)
maleic hydrazide[a] (123-33-1)
malononitrile (109-77-3)
mercury (7439-97-6)
methacrylonitrile (126-98-7)
methomyl (16752-77-5)
methoxyclor (72-43-5)
methyl bromide (bromomethane) (74-83-9)

(continued)

TABLE B-3 (continued)

Chemical

methyl chloroform (1,1,1-trichloroethane) (71-55-6)
methylene chloride[a] (75-09-2)
methyl ethyl ketone (78-93-3)
methyl iodide[a] (74-88-4)
methyl isobutyl ketone (108-10-1)
methyl isocyanate (624-83-9)
2-methyl lactonitrile (75-86-5)
methyl parathion (298-00-0)
nickel carbonyl[a] (13463-39-3)
nickel cyanide (557-19-7)
nickel refinery dust[a] (7440-02-2)
nitric oxide (10102-43-9)
nitrobenzene[a] (98-95-3)
4-nitroquinoline-1-oxide (56-57-5)
osmium tetroxide (20816-12-0)
pentachlorobenzene[a] (608-93-5)
pentachloroethane[a] (76-01-7)
pentachloronitrobenzene (82-68-8)
pentachlorophenol[a] (87-86-5)
phenol (108-95-2)
m-phenylenediamine[a] (25265-76-3)
phenylmercuric acetate (62-38-4)
phosgene (75-44-5)
phosphine (7803-51-2)
potassium cyanide (151-50-8)
potassium silver cyanide (506-61-6)
pronamide[a] (23950-58-5)
propanenitrile (107-12-0)
n-propylamine (107-10-8)
2-propyn-1-ol (107-19-7)
pyridine (110-86-1)

Chemical

selenious acid (selenium dioxide) (7783-00-8)
selenourea (630-10-4)
silver (7440-22-4)
silver cyanide (506-64-9)
silvex (93-72-1)
sodium azide (26628-22-8)
sodium cyanide (143-33-9)
styrene[a] (100-42-5)
strychnine (57-24-9)
1,2,4,5-tetrachlorobenzene (95-94-3)
1,1,1,2-tetrachloroethane[a] (630-20-6)
tetrachloroethylene[a] (127-18-4)
2,3,4,6-tetrachlorophenol (58-90-2)
tetraethyl dithiopyrophosphate (3689-24-5)
tetraethyl lead (78-00-2)
thallic oxide (1314-32-5)
thallium (7440-28-0)
thallium (1) acetate (563-68-8)
thallium (1) carbonate (6533-73-9)
thallium (1) chloride (7791-12-0)
thallium (1) nitrate (10102-45-1)
thallium (1) selenite (12039-52-0)
thallium (1) sulfate (10031-59-1)
thiomethanol (methyl mercaptan) (74-93-1)
thiosemicarbazide (79-19-6)

(continued)

TABLE B-3 (continued)

Chemical	Chemical
thiram (137-26-8)	1,2,3-trichloropropane (96-18-4)
toluene (108-88-3)	vanadium pentoxide (1314-62-1)
1,2,4-trichlorobenzene (120-82-1)	warfarin (81-81-2)
1,1,2-trichloroethane[a] (79-00-5)	xylene(s) (1330-20-7)
trichloromonofluoromethane (75-69-4)	zinc cyanide (557-21-1)
	zinc phosphide (12037-79-5)
2,4,5-trichlorophenol[a] (95-95-4)	zineb[a] (12122-67-7)

( ) = Chemical Abstracts Service (CAS) Number.

[a] Carcinogen.

oral reference dose (as of September 30, 1987),[16] or a Reference Air Concentration (RAC) found in the Agency's proposed rule on the burning of hazardous waste in boilers and industrial furnaces.[17] Additional chemicals were added to Table B-3 based on knowledge of a high toxicity associated with that substance.

B.3 EXPOSURE ASSESSMENT

Three models were used to assess exposure, and ultimately risks, for air emissions from TSDF. The Human Exposure Model (HEM) was used to calculate the number of people exposed to predicted ambient concentrations of volatile organics from equipment leaks at each of about 2,300 TSDF in the United States which included the more than 1,400 TSDF that are likely to be affected by the process vent and equipment leak standards. The results of these analyses were used to quantify annual cancer incidence. To determine the maximum lifetime cancer risk to the most exposed individual, the Industrial Source Complex Long-Term (ISCLT) model was used to estimate the highest ambient concentrations of organics in the vicinity of a worst-case TSDF. In addition, the ISCLT model was used in the evaluation of chronic noncancer health effects. Finally, the Industrial Source Complex Short-Term (ISCST) model was used to estimate ambient concentrations of individual chemicals of concern for the acute noncancer health effects assessment and as a preliminary screen for the chronic noncancer health effects assessment. Each of these is briefly described below.

B.3.1 Human Exposure Model

In addition to the composite unit risk estimate, a numerical expression of public exposure to the pollutant is needed to produce quantitative expressions of cancer incidence. The numerical expression of public exposure is based on two estimates: (1) an estimate of the magnitude and location of long-term average air concentrations of the pollutant in the vicinity of emitting sources based on air dispersion modeling; and (2) an estimate of the number of people living in the vicinity of emitting sources.

The EPA uses the Human Exposure Model (HEM) to make these quantitative estimates of public exposure and risk associated with a pollutant. The HEM uses an atmospheric dispersion model that includes local meteorological data (i.e., nearest National Weather Bureau meteorology station data) and a population distribution estimate based on 1980 Bureau of Census data to calculate public exposure.[18]

The dispersion model in HEM used data for a model plant that was placed at each TSDF location (initially about 2,300 sites). The location of each TSDF was obtained from the EPA's TSDF Industry Profile. Inputs to the initial run included a unit cancer potency estimate (1.0) and a unit emission rate (10,000 kg VOC/yr). In addition, an exit velocity and an effluent outgas temperature of 0.1 m/s and 293 °C were assumed. These inputs were used to estimate the concentration and distribution of the pollutant at distances of 200 m to 50 km from the source. The population distribution estimates for people residing near the source are based on Bureau of Census data contained in the 1980 Master Area Reference File (MARF) data base.[19] The data base is broken down into enumeration district/block group (ED/BG) values. The MARF contains the population centroid coordinates (latitude and longitude) and the 1980 population of each ED/BG (approximately 300,000) in the United States. By knowing the geographic location of the plant (latitude and longitude), the model can identify the ED/BG that fall within the 50-km radius used by HEM.

The HEM multiplies the concentration of the pollutant at ground level at each of the 160 receptors around the plant by the number of people exposed to that concentration to produce the exposure estimates. The total exposure, as calculated by HEM, is illustrated by the following equation:

$$\text{Total exposure} = \sum_{i=1}^{N} (P_i)(C_i) \quad , \qquad \text{(B-2)}$$

Σ = summation over all grid points where exposure is calculated

P_i = population associated with grid point i

C_i = long-term average pollutant concentration at grid point i

N = number of grid points.

The HEM assumes that: (1) people stay at the same location (residence) and are exposed to the same concentrations of the pollutant for 70 years; (2) the terrain around the plant is flat; and (3) concentrations of the pollutant are the same inside and outside the residence.

B.3.2 ISCLT Model

As noted above, the ISCLT model was used to estimate ambient concentrations of organics for estimating most exposed individual (MEI) risk or maximum lifetime risk for the cancer health effects assessment and the chronic noncancer effects study. The ISCLT model is a steady-state, Gaussian plume, atmospheric dispersion model that is applicable to multiple point, area, and volume emission sources. It is designed specifically to estimate long-term ambient concentrations of pollutants in the vicinity of industrial source complexes. The model was applied to the worst-case equipment leak TSDF to estimate the highest concentrations of organics and individual chemicals at various distances from the TSDF. As described later in Section B.4, the highest ambient organic concentrations are used with the equipment leak composite unit risk estimate to calculate MEI risk.

B.3.3 ISCST Model

The ISCST model was used to estimate ambient concentrations of individual hazardous waste constituents for purposes of evaluating acute, noncancer health risks. It was also used as a screening tool to identify which of the chemicals of concern in Table B-3 should be further evaluated with the ISCLT. The ISCST is similar in nature to the ISCLT, except that it is suitable for estimating short-term ambient concentrations (e.g., concentrations averaged over 1 h, 3 h, 8 h, 24 h, etc.) as well as long-term averages. ISCST was applied to two worst-case TSDF to estimate the highest constituent concentrations resulting from all types of sources at the TSDF, not just equipment leaks, for variable averaging times at the fenceline or beyond.

B.4 CANCER RISK ASSESSMENT

Three pieces of information are needed to assess the cancer risks of exposure to TSDF air emissions: (1) an estimate of the carcinogenic potency, or unit risk estimate, of the pollutants in TSDF air emissions; (2) an estimate of the ambient concentration of the pollutants from a TSDF that an individual or group of people breathe; and (3) an estimate of the number of people who are exposed to those concentrations.

Multiplying the composite unit risk estimate by (1) the numerical expressions of public exposure obtained from HEM and (2) the maximum concentration predicted by ISCLT gives two types of cancer risk measures: (1) annual incidence, a measure of population or aggregate risk, and (2) individual risk or maximum lifetime risk. The definition and calculation of annual incidence are discussed in the next section. Maximum lifetime risks are discussed in Section B.4.2.

B.4.1 Annual Cancer Incidence

One expression of risk is annual cancer incidence, a measure of aggregate risk. Aggregate risk is the summation of all the risks to people estimated to be living within the vicinity (usually within 50 km) of a source. It is calculated by multiplying the estimated concentrations of the pollutants by the unit risk estimate by the number of people exposed to different concentrations. This estimate reflects the number of excess cancers among the total population after 70 years of exposure. For statistical convenience, the aggregate risk is divided by 70 and expressed as cancer incidence per year.[20]

A unit cancer potency estimate of 1.0 and a unit emission rate of 10,000 g/yr were used as input data for HEM. Annual incidence attributed to each TSDF, as calculated by using HEM, is proportional to the cancer potency estimate and emissions. Thus, another model was used to scale the annual incidence for each TSDF by the estimated composite unit risk estimate and by the estimated organic emission that were attributed to equipment leaks at each TSDF:

$$\text{Annual incidence} = \text{HEM annual incidence} \times \frac{\begin{array}{c}\text{Composite}\\ \text{unit risk}\\ \text{estimate}\end{array}}{1.0} \times \frac{\begin{array}{c}\text{Organic}\\ \text{emissions}\\ \text{for TSDF XX}\end{array}}{10{,}000\ \text{kg}} \ . \quad \text{(B-3)}$$

The annual incidences were then summed over all TSDF. This scaling and final aggregation was performed with the Source Assessment Model (SAM). Appendix D contains a detailed description of the SAM and the emission and incidence estimation methodology used in the model.

In the estimation of annual cancer incidence for process vents, the HEM was run using site-specific emissions, local National Weather Bureau meteorology data, and 1980 population distributions for each of the WSTF identified in the 1986 National Screener Survey (of treatment, storage, disposal, and recycling facilities). Emissions for each facility were based on the quantity of solvent recycled at the facility; this quantity was also taken from the 1986 National Screener Survey. The upper and lower bound emission factors were applied to the facility throughput to determine the process vent emission range for the facility. Development of emission factors is discussed in BID Chapter 5, Sections 5.2 and 5.3. These upper and lower bound emission rates were used as input to the HEM to model each of the facilities in the data base that reported recycling solvent (or halogenated organics). The HEM results for individual facilities were aggregated to estimate nationwide cancer incidence resulting from WSTF process vent emissions. These HEM results were also used in estimating the MIR for WSTF process vents. The highest risk value predicted by HEM for all of the facilities modeled was used as the MIR risk for process vents for both the upper and lower bound emission cases.

B.4.2 Maximum Individual Risk

Maximum individual risk (MIR) refers to the persons who may live in the area of highest ambient air concentrations of the pollutant(s) as determined by the detailed facility modeling. The MIR reflects the probability of developing cancer as a result of continuous exposure to the estimated maximum ambient air concentration for 70 years. It is based only on the maximum exposure estimated by the procedure used,[21] and it does not incorporate uncertainties in the exposure estimate or the unit risk estimate.

MIR is calculated by multiplying the highest ambient air concentration by the composite unit risk estimate. The product is the probability of developing cancer for those individuals assumed to be exposed to the highest concentration for their lifetimes. Thus,

$$\text{MIR} = \begin{bmatrix} \text{Composite unit risk} \\ \text{estimate at 1 } (\mu\text{g/m}^3)^{-1} \end{bmatrix} \times \begin{bmatrix} \text{Highest} \\ \text{ambient air} \\ \text{concentration} \end{bmatrix} . \qquad \text{(B-4)}$$

B.4.3 Methodology for Specifying a "Worst-Case Facility" for TSDF Equipment Leak Emissions and Risk

B.4.3.1 Introduction. This section of Appendix B describes the methodology for developing a realistic, "worst-case" hazardous waste TSDF to estimate the maximum individual risk to a hypothetical person living nearby. The information available and the assumptions and their bases for characterizing such a facility are presented. This facility is intended to represent a TSDF that could realistically and reasonably exist and that could result in "worst-case" exposure to emissions from hazardous waste management process equipment leaks. It is not intended to be representative of all facilities in the hazardous waste management industry nor to represent a worst case that could not reasonably be expected to exist. The approach for approximating the hazardous waste TSDF industry and identifying the facility exhibiting the highest maximum risk, relying to the extent possible on the existing and available data, is presented below.

B.4.3.2 Methodology. The EPA is conducting a multiyear project to collect information on the Nation's generation of hazardous waste and the capacity available to treat, store, dispose, and recycle that waste. The initial phase of the project was the 1986 National Screening Survey that identified and collected summary information from all hazardous waste treatment, storage, disposal, and recycling facilities (TSDR) in the United States. These data served as the basis for the solvent recycling industry profile and the waste quantity used in the SAM. Phase II involved verification and updating the data provided by the active TSDR. In Phase III, all active TSDR facilities identified as having treatment, disposal, or recycling technologies were sent a detailed package of questionnaires, appropriate to the processes they operate, for the 1987 National TSDR Survey (hereafter referred to as the TSDR Survey). The completed questionnaires are reviewed for technical accuracy, and after verification the information collected is entered into a complex data base. The TSDR Survey is described in detail under Phase III of Attachment 1, National Surveys of Facilities that Generate, Treat, Store, Dispose, or Recycle Hazardous Waste. This information is the most detailed and up-to-date available.

A portion of the computerized TSDR Survey data base was available for limited use and included information and data from 1,402 facilities out of a total of 2,600. The facilities in the data base include all TSDR facilities that are commercial operations and all TSDR facilities that have some form of waste management process that involves "land disposal." Land disposal processes include surface impoundments, underground injection, land treatment, wastepiles, and landfills.

The TSDR Survey questionnaire responses contain up-to-date nationwide information regarding the hazardous waste management technologies each facility has onsite. For each facility, detailed information is available in the data base including facility area, numbers of hazardous waste management units by process type (i.e., number of surface impoundments, incinerators, and recycling units), annual throughput by process unit, and types of waste (i.e., RCRA waste codes) managed by each unit at the facility. The availability of this information in computerized format made it possible to screen the data base to identify the facilities that are expected to represent the population of worst-case facilities with regard to equipment leak emissions.

The 1,402 facilities entered in the system represented over 50 percent of the total TSDF population. Because all commercial TSDF were contained in the data base, a representative sample of large TSDF (i.e., those treating large waste volumes in a variety of waste management units and as a result those facilities expected to have the largest equipment counts, the major factor in determining equipment leak emissions), were included in the data base at the time. With regard to solvent recycling operations, the solvent recycling industry profile developed from results of the 1986 Screening Survey indicates that about 30 percent of the facilities reporting solvent recovery operations are commercial facilities, and commercial facilities report much higher throughputs than noncommercial facilities. For example, facilities reporting recycling of only halogenated organics (NOTE: Of all recycled solvents with EPA unit risk factors, nearly all are halogenated organics) in the solvent recovery units, noncommercial facilities averaged about 20,000 gallons throughput in 1985; commercial operations averaged more than 610,000 gallons throughput in 1985. Therefore, it is expected that the TSDR Survey data base used in the screening was representative of the worst-case solvent recycling population.

The following paragraphs describe the step-wise procedure to specify a worst-case facility for TSDF equipment leaks based on use of the information and data contained in the TSDR Survey. A worst-case facility was used as input to dispersion modeling to estimate maximum annual average concentration. The maximum annual average concentration was used to estimate maximum lifetime risk to nearby residents associated with equipment leak fugitive emissions.

B.4.3.2.1 Data base screened to identify facilities expected to have the highest maximum risk. Equipment counts are the most important determining factor for emission estimates from facility equipment leaks, not the amount of waste handled. Equipment counts do not double or triple as facility throughput is increased accordingly. The size of the individual equipment is also not a consideration in estimating equipment leak emissions. In addition, equipment counts (i.e., the number of pumps, valves, sampling connections, and pressure relief devices) tend to be similar for similar types of process units. These facts allow a screening approach to be used with a reasonable degree of accuracy in estimating TSDF equipment counts and equipment leak emissions.

For screening, a weighting factor that reflects relative equipment counts (i.e., the number of pumps and valves associated with each process type) was assigned to each type of hazardous waste management process. For example, a waste solvent recycling unit or a hazardous waste incinerator will have more associated pumps and valves than a storage tank or surface impoundment. Equipment counts and weighting factors based on expected equipment counts have previously been developed for a wide variety of hazardous waste management process types for use in SAM, and these factors were used to assign weights to the hazardous waste management units identified in the TSDR Survey data base. Weighting factors, rather than equipment counts, were used in the screening analysis for accounting convenience only. The equipment count weighting factors are presented in Tables B-4 and B-5.

A computerized screening of the TSDR data base was performed to identify the number of units used at each facility for each type of hazardous waste management process. The number of units were then multiplied by the appropriate equipment count weighting factor for that management process. Summing these products for all hazardous waste management process types at a facility yielded a total facility equipment

TABLE B-4. MODEL UNIT PARAMETERS

	No. of components per model unit			Emission factors, Mg/yr/component	
Equipment type (weighting factor)	A (1.0)	B (0.6)	C (0.2)	Liquid liquid	Heavy liquid
Pumps	5	3	1	0.43	0.19
Valves	165	99	33	0.062	0.002
Sampling connections	9	5	2	0.13	0.13
Open-ended lines	44	26	9	0.015	0.015
Pressure relief valves	3	2	1	0.91	0.91

TABLE B-5. MODEL UNITS ASSIGNED TO WASTE MANAGEMENT PROCESSES

Management process (weighting factor)	Uncontrolled emissions, Mg/yr
Model Unit A (1.0)	16.90
Incinerators Solvent recovery units	
Model Unit B (0.6)	10.16
Tank systems Underground injection units	
Model Unit C (0.2)	3.39
Surface impoundments Fuel blending tanks Solidification/stabilization Fuel reuse systems	

count score that reflected relative equipment counts expected at each facility. The facilities were then ranked by total facility equipment count score to identify the facility with the highest potential for total equipment leak emissions.

Emissions are not the only source-based parameter that affects ambient air concentrations and risk; the area of the facility is also of significance. For a constant emission rate, i.e., constant mass per unit time, increased area size yields lower maximum concentrations. For example, a 10-acre source with emissions of 1 Mg/yr will yield greater ambient concentrations than a 20-acre source with the same emissions.

The TSDR Survey data base contains information on the area of the TSDF; therefore, these data were also used in the screening process. The total facility equipment count score was divided by the facility area to get a screening ratio that reflected equipment counts per unit area. This screening ratio served as an index to identify the facility with the highest potential for equipment leak emissions in the smallest facility area. Sections B.4.3.2.5 and B.4.3.2.8 describe how this screening ratio and total facility equipment leak emissions were used to identify a worst-case facility when emission dispersion is considered.

B.4.3.2.2 Facilities selected for detailed analysis. About 15 to 20 facilities to be analyzed in detail were chosen based on the combination of total equipment counts (representing total emissions) and the ratio of total equipment count score to facility area (representing emission concentration). Facilities with both high equipment counts and high equipment count to area ratios served as the bases for characterizing the worst-case facility.

Two prioritized listings of facilities (one ranked on the basis of high equipment count and the second ranked on the basis of high equipment count to area ratio) were generated from the screening of the TSDR data base. Tables B-6 and B-7 present the results of the screening for the top 50 facilities in each of the two rankings. From each listing, the 10 highest-ranked facilities were selected for detailed analysis. Those facilities appearing near the top of both lists (thus representing both high emissions and small emitting area) were singled out. The facilities

TABLE B-6. 1987 TSDR SURVEY SCREENING RESULTS RANKED BY TOTAL SCORE (i.e., EQUIPMENT LEAK EMISSION POTENTIAL)

Observation	Facility area[a] (acres)	Total score[b]	Ratio of total score to facility area
1	0	109.2	0.0000
2	384	65.8	0.1714
3	750	59.6	0.0795
4	2,000	59.0	0.0295
5	832	53.0	0.0637
6	5,122	53.0	0.0103
7	30	52.8	1.7600
8	803	51.8	0.0645
9	1,600	44.4	0.0278
10	315	43.2	0.1371
11	1,000	42.2	0.0422
12	688	40.8	0.0593
13	120	40.4	0.3367
14	6	39.6	6.6000
15	1	36.8	36.8000
16	470	36.6	0.0779
17	56	36.0	0.6429
18	3,000	34.6	0.0115
19	12	32.2	2.6833
20	17	32.0	1.8824
21	3,992	31.2	0.0078
22	35	30.0	0.8571
23	1,100	30.0	0.0273
24	2,154	29.8	0.0138
25	3	29.8	9.9333
26	6	26.8	4.4667
27	18	26.8	1.4889
28	728	26.4	0.0363
29	26	26.0	1.0000
30	3	26.0	8.6667
31	43	25.8	0.6000
32	1,273	25.8	0.0203
33	14	25.8	1.8429
34	1,262	25.0	0.0198
35	6	24.4	4.0667
36	163	24.4	0.1497
37	86	24.4	0.2837
38	1,649	24.2	0.0147
39	780	23.6	0.0303
40	550	23.4	0.0425
41	160	23.2	0.1450
42	6	23.0	3.8333
43	1	22.4	22.4000
44	13	21.6	1.6615
45	4	21.2	5.3000
46	22	21.2	0.9636
47	10	21.0	2.1000
48	15	20.8	1.3867
49	1,150	20.8	0.0181
50	2	20.6	10.3000

[a] A zero value indicates that no value was reported in questionnaire response.

[b] Total score represents relative equipment leak emission potential.

TABLE B-7. 1987 TSDR SURVEY SCREENING RESULTS RANKED BY THE RATIO OF TOTAL SCORE TO FACILITY (i.e., EMISSION CONCENTRATION)

Observation	Facility area (acres)	Total score[a]	Ratio of total score to facility area
1	1	36.8	36.8000
2	1	22.4	22.4000
3	1	18.4	18.4000
4	1	11.0	11.0000
5	1	10.8	10.8000
6	2	20.6	10.3000
7	3	29.8	9.9333
8	1	9.6	9.6000
9	2	18.8	9.4000
10	2	18.0	9.0000
11	3	26.0	8.6667
12	1	8.4	8.4000
13	1	8.4	8.4000
14	1	8.2	8.2000
15	1	7.4	7.4000
16	1	7.2	7.2000
17	6	39.6	6.6000
18	1	6.6	6.6000
19	3	19.2	6.4000
20	1	6.4	6.4000
21	1	6.2	6.2000
22	2	12.2	6.1000
23	3	18.2	6.0667
24	1	5.8	5.8000
25	1	5.6	5.6000
26	1	5.6	5.6000
27	4	21.2	5.3000
28	2	10.4	5.2000
29	1	5.2	5.2000
30	2	10.2	5.1000
31	4	20.2	5.0500
32	3	15.0	5.0000
33	2	9.4	4.7000
34	2	9.4	4.7000
35	3	13.6	4.5333
36	4	18.0	4.5000
37	6	26.8	4.4667
38	1	4.4	4.4000
39	2	8.6	4.3000
40	1	4.2	4.2000
41	1	4.2	4.2000
42	2	8.4	4.2000
43	1	4.2	4.2000
44	6	24.4	4.0667
45	1	4.0	4.0000
46	6	23.0	3.8333
47	1	3.8	3.8000
48	1	3.6	3.6000
49	1	3.6	3.6000
50	1	3.6	3.6000

[a] Total score represents relative equipment leak emission potential.

chosen for the sample represent the facilities with the greatest potential for posing the maximum lifetime risk to a hypothetical person living nearby. The detailed analysis of the TSDR Survey data for these facilities is described in Sections B.4.3.2.3, B.4.3.2.4, B.4.3.2.6, and B.4.3.2.7.

B.4.3.2.3 Facility Rankings Verified and/or Adjusted. For each facility in the sample selected (see Section B.4.3.2.2), detailed information including facility area, numbers of hazardous waste management units by process type, type of waste (RCRA codes) managed by unit, and number of units planned for operation by January 1992 was available in hard copy from the TSDR Survey responses. As a quality assurance check, the information on facility area and numbers of hazardous waste management units was used to recalculate total facility equipment count scores and ratios of equipment counts to facility area. Because of the potential double- counting of some tanks (e.g., the same tank could have been reported in the fuel blending and tank systems questionnaires), when the manual check of equipment count scores and ratios was performed, corrections were made for tanks and other processes that had been double-counted or were otherwise in error.

After the quality assurance checks were completed, the prioritized lists were adjusted. The information on number of units planned for operation by January 1992 was also used in a later step (see Section B.4.3.2.6) in specifying hazardous waste management units for the worst-case facility. The type of waste managed by unit was used (see Section B.4.3.2.4) to screen equipment handling wastes with less than 10-percent organics from the analysis.

B.4.3.2.4 Screening of equipment not subject to control requirements of accelerated rule. The equipment leak provisions of the rules apply to equipment that either contains or contacts hazardous waste with organic concentrations greater than 10-percent by weight. Therefore, equipment associated with hazardous waste management units that could handle hazardous wastes with greater than 10-percent organics were identified. The TSDR Survey data base contains information on the types of hazardous wastes (RCRA codes) managed by each hazardous waste management unit at each TSDR in the sample. This information along with characterizations of each RCRA waste stream was used to screen equipment not handling wastes with organic concentrations of 10 percent or more from the analysis.

The TSDF Waste Characterization Data Base (WCDB) was used to characterize each RCRA waste stream in terms of average organic content. The WCDB was developed to support the development of the comprehensive air emission regulations for hazardous waste TSDF. Wastes listed in this data base were characterized, primarily using the following five existing data bases:

- The Westat Survey
- The Industry Studies Data Base
- A data base of 40 CFR 261.32 hazardous wastes from specific sources (i.e., waste codes beginning with the letter K)
- The WET Model Hazardous Waste Data Base
- A data base created by the Illinois EPA.

Each hazardous waste stream was characterized in terms of constituents and their percent composition.

The characterizations of hazardous waste streams in the WCDB represent national average compositions and cannot be used to accurately characterize specific waste streams or their organic content variability at a facility. That is, although a stream may average 5-percent organic content, it may at times exceed 10-percent. Therefore, it was assumed that wastes that average less than 1-percent total organics would be wastewaters and would never contain greater than 10-percent total organics. This is consistent with the Agency's definition of solvent-containing wastewaters classified as F001-F005.

Using the waste characterizations from the WCDB, hazardous waste management units that do not manage wastes with greater than 1-percent organics were eliminated from the analysis. The analysis included all streams with greater than 1-percent organic content, even those that would never exceed 10-percent, and thus overestimated emissions. Facility equipment count scores and ratios of equipment count scores to facility area were recalculated, and a new prioritized list of facilities was generated. The revised prioritized list of facilities was used (see Section B.4.3.2.6) to specify types and number of hazardous waste management units and facility area for the worst-case facility.

B.4.3.2.5 Facility selected to serve as basis for the worst-case facility. From the sample of facilities developed (see Section B.4.3.2.2), a facility was chosen to serve as the basis for the worst-case facility. The choice was made on the bases of the ratio of total equipment count score to facility area and of the total equipment count score. Facilities with the highest screening ratio of total equipment count score to facility area were chosen as candidate "worst-case facilities." The total equipment count score for these facilities was compared to the total equipment count scores of the facilities with the highest scores to ensure that a facility with high potential equipment leak emissions was chosen. A facility that had both a high screening ratio and was also high on the list of facilities prioritized by total equipment count score was chosen as the basis for the worst-case facility.

The facility selected for the worst-case facility analysis ranked 15 out of the more than 1,400 facilities in the data base in terms of total equipment scores (i.e., a direct index of potential equipment leak emissions). However, after reviewing the detailed questionnaire responses of the top scoring facilities, it was found that most did not handle wastes with organic concentrations of 10 percent or greater. For example, five out the top six facilities were found to be processing wastewaters that are not covered by the standards. Adjusting the facility equipment scores based on waste organic content puts the selected facility among the 10 highest scores. In terms of the ratio of equipment score to facility area, the selected facility ranks at the top of the list of the 1,400 facilities screened. The ratio of equipment score to facility area was used as an index of the potential for high ambient air concentrations.

B.4.3.2.6 Hazardous waste management units and facility area specified. The types and numbers of the following waste management units located at the chosen facility (see Section B.4.3.2.5) were assigned to the worst-case facility:

- Incinerators
- Units burning hazardous waste as fuel
- Fuel blending units

- Solidification/stabilization units
- Solvent recovery units
- Surface impoundments
- Underground injection wells
- Storage and treatment tanks.

In addition, transport and handling operations, such as drum and/or terminal loading were added because of the type of waste management processes at the facility. For example, a facility with solvent recycling processes would receive some wastes in drums and ship the recovered solvent from a terminal. Drum and terminal loading have associated pumps and valves but are not included in the TSDR Survey because they are not considered hazardous waste management units. However, it is likely that they handle hazardous waste with greater than 10-percent organics. Also, according to the TSDR Survey responses, such a facility plans to construct or begin operation of other waste management units before January 1992; these units were added to the worst-case facility characterization.

The actual area of the facility selected was assigned to the worst-case facility. Therefore, the types and numbers of hazardous waste management units and the facility area were based on an actual facility indicated to have a high ratio of equipment handling organic wastes to the facility area.

B.4.3.2.7 Equipment counts assigned. Assigning equipment counts (i.e., numbers of pumps, valves) followed the same procedure used in assigning the equipment weighting factors; however, in this case, the equipment counts associated with the hazardous waste management units were used rather than the weighting factors.

After the worst-case facility was specified in terms of area and numbers and types of hazardous waste management units, an "equipment" model unit was assigned to each hazardous waste management unit at the facility. Various model units were developed to represent the range of waste management processes. The model units are simplified representations of the equipment component mix expected to be associated with a particular hazardous waste management process. The model unit provides an estimate of the number of pumps, valves, open-ended lines, pressure relief valves, and sampling connections that are used in the hazardous waste management process. Although these model units are not exact for each type of process, they provide a reasonable approximation of what can be expected. Precise equipment counts for each unit at each facility are not available.

Table B-4 presents a list of equipment counts and emission factors for each equipment source within the model units. The equipment counts are calculated to be about 60 percent and 20 percent of Model Unit A for Model Unit B and Model Unit C, respectively. Model units were assigned to each waste management unit based on a review of available information on associated equipment counts. Table B-5 presents the model units assigned to the hazardous waste management processes that are contained in the TSDR Survey data base.

B.4.3.2.8 Dispersion modeling performed. The synthetic organic chemical manufacturing industry (SOCMI) equipment leak emission factors (EPA-450/3-82-010) were used to estimate fugitive organic emissions for the worst-case facility. The SOCMI emission factors were used because they are the best available for mixtures of chemicals and because TSDF have been found to handle the same chemicals as those found in the SOCMI. Uncontrolled and controlled emissions and the appropriate area source size and receptor distance served as input to a long-term modeling approach to estimate the maximum annual average concentration for the worst-case facility.

The model selected for this analysis was the Industrial Source Complex-Long-Term model (ISCLT). The ISCLT is a steady-state, Gaussian plume, atmospheric dispersion model that is applicable to multipoint, area, and volume emission sources. It is designed specifically to estimate long-term ambient concentrations resulting from air emissions from this source type. The ISCLT is recognized by the EPA Guideline on Air Quality Models as a preferred model for dealing with complicated sources (e.g., facilities with area sources) in either rural or urban areas located in flat or rolling terrain. The current UNAMAP version of ISCLT was used in all modeling applications. Several years of meteorological data from various sites around the Nation were also used in the dispersion modeling exercise to identify the highest ambient air concentrations for the worst-case facility.

The approach to characterize the facility layout was to spread the equipment leak emissions over the facility area in a uniform manner. This approach was expected to best reflect the actual facility layout. Because the worst-case facility has a large number of hazardous waste management units (i.e., equipment count) concentrated in a small area, equipment will by necessity be distributed throughout the facility area and not concentrated on one side of the facility. The dispersion modeling produced estimates of the highest ambient air concentrations for the worst-case facility for the eight cities used to characterize meteorological variations.

B.4.3.2.9 Distance specified to nearest resident. Because information on the distance from the facility boundary to the nearest residence was available for the facility serving as the basis for the worst-case facility, this distance was used in the worst-case facility analysis. The distance from the facility boundary to the nearest residence was estimated to be at least 250 ft for this particular facility.

In order to determine how this distance compares to distances for the industry as a whole, EPA utilized the preliminary results of the 1987 Generator Survey. The distance from the facility boundary to the nearest resident is not reported in the TSDR Survey. A random sample of 50 facilities was drawn from the respondents to the Generator Survey. The minimum distance to the nearest resident reported for facilities in this sample was 100 ft; the maximum reported distance was 10,000 ft. The mean (arithmetic average) for the sample was about 1,500 ft; the median distance was 1,000 ft (i.e., half of the facilities reported a distance to the nearest resident of more than 1,000 ft).

B.4.3.3 Conclusions on Selection of the Worst-Case Facility. The approach to characterizing a realistic worst-case facility described above is considered to best reflect actual worst-case conditions that could be expected at TSDF. The National TSDR Survey data are the most up-to-date, detailed, and comprehensive information available on hazardous waste management process units. Characterizing the worst-case facility based on actual highest unit/equipment counts and facility areas ensures that the representations are both reasonable and that the worst-case is based on existing data. In addition, it is taken a step beyond "actual" by locating the TSDF near the city with the worst meteorology examined and counting equipment that may not actually be covered (handling wastes containing between 1- and 10-percent organics). Finally, it should be noted that the vast number of individual URF that form the composite URF represent the 95-percent upper confidence bound, thus adding further conservatism to the risk estimates.

B.4.4 Estimates of TSDF Equipment Leak Emissions and Maximum Risk

The worst-case facility developed as the basis of the TSDF equipment leak maximum risk analysis has the following waste management units: drum handling operations, storage tanks, solvent recycling units, waste fixation/solidification, fuel blending, terminal loading/unloading, incineration, and boilers/process heaters.

B.4.4.1 Drum Handling. The worst-case facility is expected to operate an enclosed drum handling unit to unload and load organic hazardous wastes. Drum unloading is basically an assembly line operation of pumping the wastes to be processed from the drums or pumping the recovered solvent into the drums. Equipment associated with this unit have been characterized by a medium equipment-count model unit. Equipment leak emissions from this unit are estimated at 10.2 Mg/yr, uncontrolled.

B.4.4.2 Storage and Process Tanks. The worst-case facility has 28 storage and process tanks; tank sizes range from 400 gallons to 10,000 gallons. A small equipment count model unit has been assigned to each storage/process tank. Total uncontrolled organic emissions from tank-associated equipment leaks are estimated at 94.9 Mg/yr, uncontrolled.

B.4.4.3 Recycling Units. The worst-case facility recycles organic solvents that are processed in three fractionation units, four batch distillation units, and two thin-film evaporation units. Based on reported unit capacities, the recycling units' equipment counts were characterized by two large recycling model units, two medium recycling model units, and five small recycling model units. Total uncontrolled equipment leak emissions from the recycling units are estimated at 186 Mg/yr, uncontrolled.

B.4.4.4 Fixation/Solidification. The worst-case facility treats a small percent of incoming waste material in a fixation process. Treatment consists of solidification of organic waste with inert material, after which the drum waste is sent to a commercial hazardous waste landfill. A medium equipment-count model unit has been assigned to this operation, and total equipment leak fugitive emissions are estimated at 10.2 Mg/yr, uncontrolled.

B.4.4.5 Fuel Blending Tanks. The worst-case facility has five fuel blending units operating at the facility. Organic wastes not suitable for recycling are blended to meet specifications established by the end user, usually a cement kiln, and shipped in bulk. A small equipment-count model unit has been assigned to each fuel loading tank operation, and total equipment leak emissions are estimated at 17.0 Mg/yr, uncontrolled.

B.4.4.6 Transfer, Handling, and Loading. Product shipped from the worst-case facility is sent either in bulk utilizing tank trucks or in drums. Approximately 80 to 90 percent of the recovered organics sent to customers are expected to be shipped in bulk form, with the remainder sent in drums. Waste organics blended for reuse as fuel are also shipped in bulk. A medium equipment-count model unit was selected to represent this operation; total uncontrolled, equipment leak emissions from the unit are estimated at 10.2 Mg/yr.

B.4.4.7 Incineration. The designation of two incineration units at the facility is based on reported plans to install a liquid-injection incinerator and a fluidized-bed incinerator at the site. A large equipment-count model unit is used to represent equipment associated with each incineration operation; total equipment leak emissions are estimated at 33.8 Mg/yr, uncontrolled.

B.4.4.8 Boilers/Process Heaters. The worst-case facility also includes the use of a boiler process heater to dispose of organic wastes. A medium equipment-count model unit has been used to characterize equipment associated with this operation. Total equipment leak emissions are estimated at 10.2 Mg/yr, uncontrolled.

B.4.4.9 Total-Worst Case Facility Emissions. Based on the estimated equipment associated with the worst-case facility operations discussed above, the total uncontrolled equipment leak emissions for this TSDF/WSTF are estimated at 373 Mg/yr. Table B-8 summarizes these emissions by source category.

B.4.4.10 Maximum Risk. Table B-9 presents the maximum risk resulting from uncontrolled and controlled equipment-leak emissions from the worst-case facility for the urban situation at varying distances from the edge of the area source. The emission rate of 373 Mg/yr was used to calculate maximum risk based on the ISCLT dispersion estimates for emissions from an area source conducted by EPA/ESD/SRAB. Eight cities around the Nation were modeled using a minimum of 5 years of meteorological data to identify highest ambient air concentrations for the worst-case situations. Table B-10 presents the dispersion modeling results. It is of interest to note that the highest ambient concentrations were found to occur in the city that is the location of the facility selected to represent the worst case.

B.4.4.11 Equipment Leak MIR Results. Based on results of the analyses described above, the revised MIR estimates for TSDF equipment leak emissions are as follows:

Control Case	MEI
Uncontrolled	5×10^{-3}
Option 1	1×10^{-3}
Option 2	1×10^{-3}

The MIR risks were calculated using the highest annual average concentration at the receptor distance of 250 ft and using the TSDF equipment leak source-specific, emission-weighted unit risk factor of 4.5×10^{-6} $(\mu g/m^3)^{-1}$.

B.5 NONCANCER HEALTH EFFECTS

B.5.1 Chronic Exposures

The assessment of noncancer health effects associated with chronic exposures to TSDF chemicals of concern is based on a comparison of the chemical-specific health benchmark levels (as discussed in Section B.2.1) to estimated ambient concentrations at various receptor locations around a facility. Inhalation exposure limits are compared to the highest annual

TABLE B-8. WORST-CASE FACILITY EQUIPMENT LEAK EMISSIONS BY SOURCE CATEGORY[a]

Source category	Uncontrolled emissions, Mg/yr	Option 1 emissions,[b] Mg/yr	Option 2 emissions,[c] Mg/yr
Drum handling	10.2	2.78	2.36
Storage and process tanks	94.9	26.0	22.0
Solvent recycling units	186.0	51.0	43.2
Fixation/solidification	10.2	2.78	2.36
Fuel blending	17.0	4.64	3.93
Transfer, handling, and loading	10.2	2.78	2.36
Incineration	33.8	9.26	7.84
Boilers/process heaters	10.2	2.78	2.36
Total	373	102	86.4

[a] Includes equipment leaks from pump seals, valves, open-ended lines, samling connections, and pressure relief valves.

[b] Option 1 includes leak detection and repair requirements for pumps and valves, caps for open-ended lines, closed-purge sampling, and rupture disks for pressure-relief devices.

[c] Option 2 includes leak detection and repair for valves, dual mechanical seals and associated equipment for pumps, caps for open-ended lines, closed-purge sampling, and rupture disks for pressure-relief devices.

TABLE B-9. MAXIMUM RISK FROM EQUIPMENT LEAKS FOR A WORST-CASE FACILITY (TSDF/WSTF)[a]

Distance, ft	Maximum risk		
	Uncontrolled	Option 1	Option 2
50	2×10^{-2}	5×10^{-3}	4×10^{-3}
100	1×10^{-2}	3×10^{-3}	3×10^{-3}
250[b]	5×10^{-3}	1×10^{-3}	1×10^{-3}
500	2×10^{-3}	5×10^{-4}	4×10^{-4}
1,000	7×10^{-4}	2×10^{-4}	2×10^{-4}
2,000	2×10^{-4}	6×10^{-5}	5×10^{-5}
4,000	7×10^{-6}	2×10^{-5}	2×10^{-5}

[a] Based on the highest annual average ambient concentration at the receptor distance for the eight cities modeled by the ISCLT, a worst-case emission rate of 373 Mg/yr (11.8 g/s) uncontrolled, and an URF of 4.5×10^{-6} $(\mu g/m^3)^{-1}$.

[b] The minimum distance to the nearest residence for the facility serving as the basis for the worst-case facility analysis.

TABLE B-10. SUMMARY OF AMBIENT CONCENTRATION ESTIMATES FROM A PROTOTYPE TSDF IN AN URBAN LOCATION AT VARIOUS DISTANCES[a]

City	Distance, ft						
	50	100	250	500	1,000	2,000	4,000
Houston	235.2	138.1	53.9	21.8	7.64	2.48	0.79
Baton Rouge	291.2	168.1	61.9	24.4	8.61	2.81	0.90
Cleveland	267.1	162.3	62.6	23.7	8.15	2.60	0.82
Charleston	218.7	132.7	51.5	20.7	7.24	2.35	0.75
Chester	261.4	155.7	58.5	22.7	7.78	2.48	0.78
Newark	200.2	119.4	44.3	16.8	5.67	1.78	0.55
Wyandotte	191.1	114.6	42.9	16.6	5.68	1.80	0.56
Santa Monica	329.7	217.8[b]	91.7	35.9	12.2	3.92	1.22

[a] All concentrations are in micrograms per cubic meter.

[b] The highest annual average concentration at the minimum receptor distance used in the calculation of MIR risk.

average ambient concentration for each chemical at the selected facilities. These annual concentrations represent an estimation of the highest average daily ambient concentration experienced over a year. Ambient concentrations that are less than the RfD are not likely to be associated with health risks. The probability that adverse effects may be observed in a human population increases as the frequency of exposures exceeding the RfD increases and as the size of the excess increases.

Because Agency-verified RfD are not available, an interim screening approach was used. The likelihood of adverse noncancer health effects was determined by comparing modeled ambient concentrations of individual constituents to the available health data. These health data are obtained from various sources, including EPA reports and documents, data used to support occupational exposure recommendations and standards (e.g., American Conference of Governmental Industrial Hygienists, Documentation of the Threshold Limit Values), and other published information. An assessment of the potential for adverse noncancer health effects was made case-by-case, considering: (1) the magnitude of the differences between the exposure concentration and the lowest-observed-adverse-effect level or the no-observed-adverse-effect level, and (2) the quality of the health effects data base. In general, the likelihood of noncancer health effects was considered to be low if modeled concentrations are several orders of magnitude below the health effect levels of concern. The probability that such effects will occur increases with increasing exposure concentrations. This screening effort was used only to give a preliminary indication of the potential for noncancer health effects.

B.5.2 Acute Exposures

An assessment of the potential for noncancer health effects associated with short-term (acute) exposure to TSDF chemicals of concern at selected facilities was conducted as a screening effort to provide additional qualitative support to the overall noncancer health effects analysis. In addition to the lack of short-term inhalation health benchmark levels at this time, acute inhalation data are limited for many of the TSDF chemicals of concern. The assessment was conducted by comparing maximum modeled ambient concentrations for averaging times of 15 min, 1 h, 8 h, and 24 h to available short-term health data matched to the appropriate averaging time. A determination of the risk of adverse health effects associated with estimated short-term exposures was based on a consideration of the quality of the available health data and the proximity of the exposure concentration to the health effect level.

B.5.3 Results of Noncancer Health Effects Analysis

A screening analysis of the potential adverse noncancer health effects associated with acute and chronic exposure to individual waste constituents emitted from TSDF was conducted by EPA. This analysis was based on a comparison of relevant health data to the highest short-term or long-term modeled ambient concentrations for chemicals at each of the two selected TSDF. Results of this analysis suggest that adverse noncancer health effects are unlikely to be associated with acute or chronic inhalation exposure to TSDF organic emissions on a nationwide basis. It should be noted that the health data base for many chemicals was limited, particularly for short-term exposures. The conclusions reached in this preliminary analysis should be considered in the context of the limitations of the health data; the uncertainties associated with the characterization of wastes at the facilities; and the assumptions used in estimating emissions, ambient concentrations, and the potential for human exposure. Additional evaluation of noncancer health effects will be considered as part of the third phase of the TSDF regulatory program.

B.6 ANALYTICAL UNCERTAINTIES APPLICABLE TO CALCULATIONS OF PUBLIC HEALTH RISKS IN THIS APPENDIX

B.6.1 Unit Risk Estimate

The procedure generally used to develop unit risk estimates is fully described in Reference 1, using nickel as an example. The low-dose extrapolation model used and its application to epidemiological and animal data have been the subjects of substantial comment by health scientists. The uncertainties are too complex to be summarized in this appendix. Readers who wish to go beyond the information presented in the reference should see the following Federal Register notices: (1) EPA's "Guidelines for Carcinogenic Risk Assessment," 51 FR 33972 (September 24, 1986), and (2) EPA's "Chemical Carcinogens; A Review of the Science and Its Associated Principles," 50 FR 10372 (March 14, 1985), February 1985.

Significant uncertainties associated with the cancer unit risk estimates include: (1) selection of dose-response model, (2) selection of study used to estimate the unit risk estimate, and (3) presence or absence of a threshold. Uncertainties related to the composite risk estimate include the assumption of additivity of carcinogenic risk. According to the EPA "Guidelines for the Health Risk Assessment of Mixtures," a number of factors such as data on similar mixtures and the interactions among chemicals must be considered before additivity can be assumed.[22] Because of the sheer number of chemicals emitted from TSDF and the lack of specific information on particular compounds, EPA assumed additivity.

B.6.2 Public Exposure

B.6.2.1 General. The basic assumptions implicit in the methodology are that all exposure occurs at people's residences, that people stay at the same location for 70 years, that the ambient air concentrations and the emissions that cause these concentrations persist for 70 years, and that the concentrations are the same inside and outside the residences. From this it can be seen that public exposure is based on a hypothetical rather than a realistic premise. It is not known whether this results in an overestimation or an underestimation of public exposure.

B.6.2.2 The Public. The following are relevant to the public as dealt with in this analysis:

- Studies show that all people are not equally susceptible to cancer. There is no numerical recognition of the "most susceptible" subset of the population exposed.

- Studies indicate that whether or not exposure to a particular carcinogen results in cancer may be affected by the person's exposure to other substances. The public's exposure to other substances is not numerically considered.

- Some members of the public included in this analysis are likely to be exposed to compounds in the air in the workplace, and workplace air concentrations of a pollutant are customarily much higher than the concentrations found in the ambient or public air. Workplace exposures are not numerically approximated.

- Studies show that there is normally a long latency period between exposure and the onset of cancer. This has not been numerically recognized.

- The people dealt with in the analysis are not located by actual residences. As explained previously, they are "located" in the Bureau of Census data for 1980 by population centroids of census districts.

- Many people dealt with in this analysis are subject to exposure to ambient air concentrations of potentially toxic pollutants where they travel and shop (as in downtown areas and suburban shopping centers), where they congregate (as in public parks, sports stadiums, and school yards), and where they work outside (as mailmen, milkmen, and construction workers). These types of exposures are not dealt with numerically.

B.6.2.3 Ambient Air Concentrations. The following are relevant to the estimated ambient air concentrations used in this analysis:

- Flat terrain was assumed in the dispersion model. Concentrations much higher than those estimated would result if emissions impact on elevated terrain or tall building near a plant.

- The estimated concentrations do not account for the additive impact of emissions from plants located close to one another.

- Meteorological data specific to plant sites are not used in the dispersion model. As explained, meteorological data from a National Weather Service station nearest the plant site are used. Site-specific meteorological data could result in significantly different estimates, e.g., the estimates of where the higher concentrations occur.

- With few exceptions, the emission rates are based on assumptions and on limited emission tests. See the Background Information Document for details on each source.

B.7 REFERENCES

1. U.S. Environmental Protection Agency. Health Assessment Document for Nickel and Nickel Compounds. Publication No. EPA-600/8-83-012FF. Office of Health and Environmental Assessment, Washington, DC. 1986. p. 8-156.

2. Reference 1, p. 8-156.

3. U.S. Environmental Protection Agency. Carcinogen Assessment of Coke Oven Emissions. Publication No. EPA-600/6-82-003F. Office of Health and Environmental Assessment. Washington, DC. 1984. p. 147.

4. Reference 1, p. 8-161.

5. Reference 1, p. 8-179.

6. Reference 1, p. 8-162.

7. Reference 1, p. 8-179.

8. U.S. Environmental Protection Agency. Health Assessment Document for Carbon Tetrachloride. Publication No. EPA-600/8-82-001F. Environmental Criteria and Assessment Office, Cincinnati, OH. 1984. p. 12-10.

9. U.S. Environmental Protection Agency. Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Final Rule. 51 FR 28296. 1986.

10. Memorandum from Lisa Ratcliff, EPA, to Bob Scarberry and Debra Dobkowski, EPA. June 29, 1987. Inhalation exposure limits.

11. Reference 10.

12. Memorandum from Branscome, M., RTI, to Docket. September 28, 1988. Calculation of composite unit risk estimates.

13. U.S. Environmental Protection Agency. Guidelines for Carcinogen Risk Assessment. 51 FR 33992. September 24, 1986.

14. Reference 9.

15. Memorandum from Coy, Dave, RTI, to McDonald, Randy, EPA/OAQPS. May 2, 1986. Listing of waste constituents prioritized by quantity in Industry Studies Data Base, combined with WESTAT Survey and WET Model.

16. U.S. Environmental Protection Agency. Status Report of the RfD Work Group. Environmental Criteria and Assessment office, Cincinnati, OH. 1987.

17. U.S. Environmental Protection Agency. Burning of Hazardous Waste in Boilers and Industrial Furnaces; Preamble Correction. 52 FR 25612. 1987.

18. U.S. Environmental Protection Agency. User's Manual for the Human Exposure Model (HEM). Office of Air Quality Planning and Standards, Research Triangle park, NC. Publication No. EPA/450/5-86-001. 1986.

19. Department of Commerce. Local Climatological Data. Annual Summaries with Comparative Data.

20. U.S. Environmental Protection Agency. Inorganic Arsenic NESHAPs: Response to Public Comments on Health, Risk Assessment, and Risk

Management. Publication No. EPA/450-5-85-001. Office of Air Quality, Planning, and Standards, Research Triangle Park, NC. p. 4-13.

21. Reference 20, p. 4-18.

22. U.S. Environmental Protection Agency. Guidelines for the Health Risk Assessment of Chemical Mixtures. 51 FR 34014. September 24, 1986.

APPENDIX C

CONTROL COSTS

RESEARCH TRIANGLE INSTITUTE

Center for Environmental Systems

DRAFT

January 6, 1989

MEMORANDUM

TO: Rick Colyer, EPA/SDB and Bob Lucas, EPA/CPB

FROM: Steve York, RTI

SUBJECT: Estimation of Nationwide Control Costs and Cost Effectiveness of Implementing Accelerated Rule

The estimated nationwide upper bound and lower bound control costs and cost effectiveness of implementing the accelerated rule are presented in the attached tables. Table 1 presents the nationwide capital and annualized costs of implementing solvent recycling facility/TSDF fugitive emission controls. The solvent recycling facility fugitive emission control costs are based on the model unit costs presented in the January 26, 1988 memorandum from Robert Zerbonia to Rick Colyer, SDB and Bob Lucas, CPB regarding the costs for fugitive emission control at WSTF/TSDF model units. The solvent recycling facility costs are for 99 large facilities, 207 medium facilities, and 250 small facilities representing 448 WSTF and 108 recycling facilities without solvent recovery on site reusing solvent as fuel. The TSDF fugitive emission control costs were calculated using the Source Assessment Model (SAM) and represent the estimated costs of controlling emissions from fugitive sources handling hazardous wastes consisting of 10 percent or greater total organic content. The SAM was used to estimate TSDF fugitive emission control costs because it can access the comprehensive TSDF industry profile to identify affected facilities managing waste streams greater than 10 percent organics and it accounts for throughput in generating control cost estimates. There were more than 1400 TSDF that were projected to handle waste affected by the standards. Recovery credits are not included for fugitive emission controls because most of the control costs are associated with TSDF and commentors on the proposed rule pointed out that a recovery credit is not reasonable to assume for a TSDF which is not recycling.

Table 1 also presents the nationwide capital and annualized costs and cost effectiveness of implementing WSTF process vent controls. The control costs for the 95 percent emission reduction are based on the model unit costs presented in the January 26, 1988, memorandum from Robert Zerbonia, RTI to Rick Colyer, EPA/SDB and Robert Lucas, EPA/CPB regarding the model unit condenser and carbon adsorption cost estimates. The WSTF costs are for 73 large facilities and 167 medium facilities. The 208 small facilities as defined for the post-proposal analysis (see the January 27, 1988, memorandum from Steve York and Robert Zerbonia, RTI to Rick Colyer, EPA/SDB and Robert Lucas, EPA/CPB regarding the estimation of nationwide uncontrolled VO emissions from solvent recycling facilities for the Accelerated Rule post-proposal analysis) are not required to add control devices under the 3 lb/hr facility emission rate cutoff. The estimated number of WSTF might include some TSDF with process vents since only 406 of the 448 WSTF (including the 208 small facilities) reported handling waste solvents in the 1986 Screener Survey. The remaining 42 facilities reported recycling other hazardous wastes in solvent recycling operations; 29 of these 42 reported recycling halogenated organics.

The analysis of the technical feasibility of attaining the 95 percent emission reduction is based on the use of condensers to control process vent streams for which condensation will achieve 95 percent control and on the use of carbon adsorption systems to control the remaining process vent streams subject to the regulations. Since insufficient site specific information is available to determine which facilities could apply condensation rather than carbon adsorption, upper and lower bound cost estimates were generated for the 95 percent emission reduction. The upper bound cost estimates are based on the assumption that fixed-bed, regenerable carbon adsorption systems would be required to control process vents at all facilities with emissions above the emission rate cutoff. Similarly, the lower bound cost estimate is based on the assumption that vent condensers could be used to control process vents at all facilities with emissions above the emission rate cutoff.

Table 2 presents the nationwide costs of implementing the accelerated rule. The two control options represent combinations of fugitive emission and process vent control yielding upper and lower bound nationwide cost estimates.

SBY/ddf

TABLE 1. NATIONWIDE[a] COSTS AND COST EFFECTIVENESS OF IMPLEMENTING
SOLVENT RECYCLING FACILITY/TSDF FUGITIVE EMISSION CONTROLS

Control Option	Solvent Recycling Facilities		TSDF		Nationwide Total			
	Capital Cost, $1986\$ \times 10^{-6}$	Annual Cost,[b] $\$/yr \times 10^{-6}$	Capital Cost, $1986\$ \times 10^{-6}$	Annual Cost,[c] $\$/yr \times 10^{-6}$	Capital Cost, $1986\$ \times 10^{-6}$	Annual Cost, $\$/yr \times 10^{-6}$	Emission Reduction, Mg/yr	Cost Effectiveness, $/Mg
Equipment[e] Leaks	13.4	3.6	113.2	29.3	126.6	32.9	19,000	480(1730)
Process Vents[f]							7,200	
Upper Bound	24.8	12.9	--	--	24.6	12.9		1,800
Lower Bound	1.5	(0.07)	--	--	1.5	(0.07)		30(2000)

[a] Solvent recycling facility equipment leak fugitive emissions control costs are based on the model unit costs presented in the January 26, 1988, memorandum from Robert Zerbonia to Rick Colyer, SDB and Bob Lucas, CPB regarding the costs for fugitive emission control at WSTF/TSDF model units. The solvent recycling facility costs are for 73 large facilities, 187 medium facilities, and 208 small facilities representing 448 WSTF and 108 recycling facilities without solvent recovery on site reusing solvent as fuel is discussed in the January 27, 1988 memorandum from Steve York and Robert Zerbonia, RTI to Rick Colyer, EPA/SDB and Robert Lucas, EPA/CPB regarding the estimation of nationwide uncontrolled VO emissions from solvent recycling facilities for the Accelerated Rule post-proposal analysis. TSDF equipment leak fugitive emission control costs were calculated using the Source Assessment Model (SAM) and represent the estimated costs of controlling equipment leak fugitive emissions from sources handling hazardous wastes with 10 percent or greater total organic content. WSTF process vent control costs are based on the model unit costs presented in the Janaury 26, 1988, memorandum from Robert Zerbonia, RTI to Rick Colyer, EPA/SDB and Robert Lucas, EPA/CPB regarding the model unit condenser and carbon adsorption cost estimates. The WSTF costs are for 73 large facilities and 187 medium facilities. Small facilities as defined for the post-proposal analysis (see the January 27, 1988, memorandum from Steve York and Robert Zerbonia, RTI to Rick Colyer, EPA/SDB and Robert Lucas, EPA/CPB regarding the estimation of nationwide uncontrolled VO emissions from solvent recycling facilities for the Accelerated Rule post-proposal analysis are not required to install controls under the 1.4 kg/hr and 2.8 Mg/yr facility process vent emission rate cutoff.

[b] Includes recovery credits. ( ) indicates a net cost credit.

[c] Does not include recovery credits.

[d] The emission reduction for controlling process vent organic emissions is based on the emission reduction achieved by the 187 medium size facilities (>50,000 gallons throughput) and the 73 large facilities (>1,000,000 gallons throughput). The total emission reduction represents the reductions necessary to bring each facility down to 2.8 Mg/yr (the standard cutoff) or reduce total process vent emissions by 95 percent. It is estimated that only 22 of the WSTF would be required to reduce emissions to the 95 percent level without reaching the 2.8 Mg/yr cutoff. The 7200 Mg emission reduction value is with the high emission factor applied to the solvent throughput.

[e] Implementation of a monthly leak detection and repair program for pumps and valves and installation of leakless controls on pressure relief devices, sampling connections, and open-ended lines.

[f] The upper bound cost estimates for the process vent control are based on the assumption that fixed-bed, regenerable carbon adsorption systems would be required to control process vents at all facilities with emissions above the emission rate cutoff. The nationwide costs are based on an average of the costs of carbon adsorption systems for large model unit cases 5, 8 and 9 applied to the 73 large facilities and on the cost of the carbon adsorption system for medium model unit case 25 applied to the 187 medium facilities. Model unit cases are defined in the November 18, 1987, memorandum cited above. The lower bound cost estimates are based on the assumption that condensers could be used to control process vents at all facilities with emissions above the emission rate cutoff. The nationwide costs are based on an average of the costs of condensers for large model unit cases 6, 7, 10, 11 and 12 applied to the 73 large facilities and on an average of the costs of condensers for medium model unit cases 26, 27, and 28 applied to the 187 medium facilities.

TABLE 2. Nationwide Capital and Annualized Costs of Implementing Accelerated Rule

Cost Range	Nationwide Capital Cost, 1986 $ x 10^{-6}	Nationwide Annual Cost, $/yr x 10-6	Emission Reduction, Mg/yr	Cost Effectiveness $/Mg
Upper Bound	151.2	45.8	26,200	1750
Lower Bound	128.1	32.8	19,000	1730

RESEARCH TRIANGLE INSTITUTE

Center for Environmental Systems

January 26, 1988

DRAFT

MEMORANDUM

TO: Rick Colyer, EPA/SDB and Robert Lucas, EPA/CPB

FROM: Robert Zerbonia, RTI

SUBJECT: Model Unit Condenser and Carbon Adsorber Cost Estimates

The WSTF control costs for Options I and II cases that involve the use of condensers for VO emission control were estimated using a chemical engineering process simulator known as ASPEN (Advanced System for Process Engineering). Table 1 provides the chemical constituents and operating conditions that were used in the ASPEN runs as well as the condenser efficiencies that were generated. The ASPEN condenser configuration consists of: (1) a floating-head, 1-pass, shell and tube heat exchanger, (2) a refrigeration unit capable of producing chilled brine at a temperature of ⁻20°F, and (3) an optional primary water-cooled heat exchanger. This final item might be necessary in some instances of volatile organic condensation to reduce the size of the refrigeration unit or to remove water vapor and avoid freezing problems. In this design effort, RTI has assumed complete removal of water vapor prior to VO condensation, recognizing that the condenser temperature is low enough to cause ice build up on heat transfer surfaces.

ASPEN's cost correlation for heat exchangers, developed originally for plant-scale processes, does not extend to the low flows examined for WSTF. Therefore, vendor quotes (e.g., $2050 from Brink's Inc. for a heat transfer area of 25 square feet) were added to ASPEN to allow cost scaling by condenser area for the low flows. A 25% over design factor was added to the calculated (theoretical) condenser areas to determine capital costs. Tables 2, 3, and 4 provide the costs and cost effectiveness numbers for the large, medium, and small model unit cases, respectively.

In the ASPEN condenser model, a small refrigeration unit was included to achieve a target condensation efficiency of 95%. The unit produces coolant (e.g., chilled brine) for the heat exchanger at a temperature of -20°F; coolant flow is on the shell side of the condenser. It is of interest to note that in only 15 of the 40 cases examined was a removal efficiency of 95 percent achievable. The efficiency of vent condensers is dependent of the physical properties of the solvents being condensed, the solvent concentration in the gas stream, and the operating temperature of the condenser.

In seven (7) of the 40 cases, ASPEN indicated that for those particular situations appreciable condensation would not occur. This results from the partial pressure of the VO in the vapor phase being too low to thermodynamically support a liquid phase. Six of the seven cases involved methylene chloride as the VO constitutent; methylene chloride has a boiling point of 40°C (a relatively low boiling/high volatility compound). This compares with boiling points of 110°C, 79°C, and 74°C for toluene, MEK, and 1,1,1 TCE, respectively. The seventh case that would not condense was a low concentration (1%) MEK.

For cases where condensation will not achieve a 95 percent control VO reduction, carbon adsorption will be used as the control technology for the emission reduction and cost analysis. Those cases where carbon absorption is the control technology used to achieve the 95 percent reduction in VO emissions as called for under Option I are Case No. 5, 8, 9, 17, 18, 19, 20, 21, 25, 33, 36, and 37. Table 5 presents the costs and cost effectiveness numbers for Option 1 controls using carbon adsorption. All carbon adsorption costs were estimated using the EPA/EAB CONTROL COST MANUAL, EPA 450/5-87-001A, February 1987.

There are twelve model unit cases that are below the Accelerated Rule regulatory applicability cut-off of 10% VO content; these are Cases 1-4, 13-16, and 29-32. Although condensation is achievable and costs were generated for some of these cases, these costs will not be included in the nationwide costs of the regulation since the unit would not be affected by the regulation as proposed.

RAZ/ddf

Enclosure

NOTE: This memo was written prior to the decision to drop the proposed 10 percent concentration cutoff.

TABLE 1. OPERATING CONDITIONS USED IN ASPEN CONDENSER ESTIMATES AND CONDENSER CONTROL EFFICIENCIES PREDICTED FOR MODEL UNIT CASES.

CASE NO.	TOTAL FLOW (SCFM)	VO RATE (LB/HR)	CONSTITUENT	OP HRS (HR)	VO PERCENT	CONDEN EFF , (%)
1	8.3	0.40	ME CHL	4160	1%	NC
2	8.3	0.40	TOL	4160	1%	45
3	8.3	0.40	1,1,1 TCE	4160	1%	16
4	8.3	0.40	MEK	4160	1%	NC
5	8.3	4.20	ME CHL	4160	11%	NC
6	8.3	4.20	TOL	4160	11%	95
7	8.3	4.20	1,1,1 TCE	4160	11%	95
8	8.3	4.20	MEK	4160	11%	87
9	8.3	10.60	ME CHL	4160	25%	44
10	8.3	10.60	TOL	4160	25%	95
11	8.3	10.60	1,1,1 TCE	4160	24%	95
12	8.3	10.60	MEK	4160	25%	95
13	1.2	0.17	ME CHL	2080	3%	NC
14	1.2	0.17	TOL	2080	3%	82
15	1.2	0.17	1,1,1 TCE	2080	3%	72
16	1.2	0.17	MEK	2080	3%	50
17	1.2	0.42	ME CHL	2080	10%	NC
18	1.2	0.42	TOL	2080	10%	82
19	1.2	0.42	1,1,1 TCE	2080	10%	89
20	1.2	0.42	MEK	2080	10%	80
21	1.2	1.20	ME CHL	2080	20%	26
22	1.2	1.20	TOL	2080	20%	95
23	1.2	1.20	1,1,1 TCE	2080	20%	95
24	1.2	1.20	MEK	2080	20%	95
25	1.2	5.00	ME CHL	2080	59%	87
26	1.2	5.00	TOL	2080	58%	95
27	1.2	5.00	1,1,1 TCE	2080	55%	95
28	1.2	5.00	MEK	2080	61%	95
29	0.6	0.08	ME CHL	2080	3%	NC
30	0.6	0.08	TOL	2080	3%	80
31	0.6	0.08	1,1,1 TCE	2080	3%	70
32	0.6	0.08	MEK	2080	3%	47
33	0.6	0.24	ME CHL	2080	10%	NC
34	0.6	0.24	TOL	2080	10%	95
35	0.6	0.24	1,1,1 TCE	2080	10%	90
36	0.6	0.24	MEK	2080	10%	83
37	0.6	1.00	ME CHL	2080	31%	58
38	0.6	1.00	TOL	2080	30%	95
39	0.6	1.00	1,1,1 TCE	2080	30%	95
40	0.6	1.00	MEK	2080	31%	95

NC = NO CONDENSATION.

TABLE 2. ASPEN CONDENSER DESIGN AND COST ESTIMATES FOR THE LARGE MODEL UNIT CASES (1-12), OPTION 1

PARAMETER CASE NO.	1	2	3	4	5	6	7	8	9	10	11	12
Coolant Temperature (F)		-20	-20			-20	-20	-20	-20	-20	-20	-20
Design Heat Load (Watt)		292	282			572	468	608	557	917	722	1184
Required Condenser Area (sq. m)		0.319	0.307			0.624	0.51	0.663	0.607	0.591	0.561	1.28
Refrigeration Capacity (tons)		0.08	0.08			0.16	0.13	0.17	0.16	0.26	0.21	0.34
Heat Exchanger Base Cost (1986 $)		940	930			1270	1160	1300	1250	1240	1210	1740
Refrigeration Base Cost (1986 $)		1600	1560			2540	2210	2650	2490	3510	2980	4180
Electricity, Refrigeration (1986 $)		a	a			a	a	a	a	a	a	a
BASE EQUIPMENT COST (1986 $)		2550	2490			3810	3370	3950	3740	4750	4190	5920
TOTAL CAPITAL INVESTMENT (1986 $)		5050	4940			7550	6690	7840	7430	9420	8310	11740
TOTAL ANNUAL COST (1986 $)		2870	2850			3420	3230	3430	3400	3830	3590	4340
RECOVERY CREDIT ($/Yr)		150	50			3400	3400	3090	3930	8570	8570	8570
COST EFFECTIVENESS ($/Mg VO removed)		8160	25200			0	-20	60	-60	-250	-260	-220

NOTES:

a) Costs are less than $100.

1. Instrumentation: 10% of Base Equipment Cost (BEC).
2. Sales tax and freight: 8% of BEC + Instr.
3. Purchased Equipment Cost (PEC): BEC + Instr. + Sales Tax & Freight.
4. Total Installation Cost (Direct + Indirect): 67% of PEC
5. Total Capital Investment (TCI): PEC + Total Installation Cost
6. Supervision and Admin. Labor: 15% of Direct Labor.
7. Maintenance Labor and Materials: 3% of TCI.
8. Overhead: 60% of Op. Labor + Supv./Adm. + Maint.
9. Property Taxes, Insurance, and Admin. Charges: 4% of TCI.
10. Capital Recovery: 10% over a 15-year service life.

TABLE 3. ASPEN CONDENSER DESIGN AND COST ESTIMATES FOR THE MEDIUM MODEL UNIT CASES (13-28), OPTION 1

PARAMETER CASE NO.	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Coolant Temperature (F)		-20	-20	-20		-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20
Design Heat Load (Watt)		51	46	48		51	58	71	60	114	93	141	294	355	240	420
Required Condenser Area (sq. m)		0.055	0.05	0.053		0.055	0.064	0.077	0.065	0.082	0.083	0.154	0.32	0.18	0.122	0.221
Refrigeration Capacity (tons)		0.01	0.01	0.01		0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.08	0.1	0.07	0.12
Heat Exchanger Base Cost (1986 $)		440	420	430		440	460	510	470	520	520	690	950	730	620	800
Refrigeration Base Cost (1986 $)		480	450	470		480	530	610	540	840	730	970	1610	1830	1400	2050
Electricity, Refrigeration (1986 $)		a	a	a		a	a	a	a	a	a	a	a	a	a	a
BASE EQUIPMENT COST (1986 $)		920	870	890		920	1000	1110	1010	1360	1250	1660	2550	2560	2020	2860
TOTAL CAPITAL INVESTMENT (1986 $)		1820	1730	1770		1820	1980	2210	2000	2690	2480	3290	5070	5090	4000	5670
TOTAL ANNUAL COST (1986 $)		2170	2150	2160		2170	2200	2250	2210	2360	2310	2490	2880	2880	2650	3010
RECOVERY CREDIT ($/Yr)		60	50	40		150	160	140	130	490	490	490	1850	2020	2020	2020
COST EFFECTIVENESS ($/Mg VO removed)		15830	18900	23850		6060	5740	6780	7200	1720	1670	1840	250	190	140	220

NOTES:

a) Costs are less than $100.

1. Instrumentation: 10% of Base Equipment Cost (BEC).
2. Sales tax and freight: 8% of BEC + Instr.
3. Purchased Equipment Cost (PEC): BEC + Instr. + Sales Tax & Freight.
4. Total Installation Cost (Direct + Indirect): 67% of PEC
5. Total Capital Investment (TCI): PEC + Total Installation Cost
6. Supervision and Admin. Labor: 15% of Direct Labor.
7. Maintenance Labor and Materials: 3% of TCI.
8. Overhead: 60% of Op. Labor + Supv./Adm. + Maint.
9. Property Taxes, Insurance, and Admin. Charges: 4% of TCI.
10. Capital Recovery: 10% over a 15-year service life.

TABLE 4. ASPEN CONDENSER DESIGN AND COST ESTIMATES FOR THE SMALL MODEL UNIT CASES (29-40), OPTION 1

PARAMETER	CASE NO.	29	30	31	32	33	34	35	36	37	38	39	40
Coolant Temperature (F)			-20	-20	-20		-20	-20	-20	-20	-20	-20	-20
Design Heat Load (Watt)			25	23	24		37	31	38	55	79	61	103
Required Condenser Area (sq. m)			0.027	0.025	0.026		0.04	0.33	0.042	0.06	0.046	0.041	0.089
Refrigeration Capacity (tons)			0.01	0.01	0.01		0.01	0.01	0.01	0.02	0.02	0.02	0.03
Heat Exchanger Base Cost (1986 $)			320	310	310		380	350	390	450	400	380	540
Refrigeration Base Cost (1986 $)			300	280	290		390	340	400	510	660	540	790
Electricity, Refrigeration (1986 $)			a	a	a		a	a	a	a	a	a	a
BASE EQUIPMENT COST (1986 $)			616	590	600		760	690	780	960	1060	930	1320
TOTAL CAPITAL INVESTMENT (1986 $)			1220	1160	1190		1520	1370	1550	1900	2100	1840	2520
TOTAL ANNUAL COST (1986 $)			2030	2020	2030		2100	2070	2110	2180	2230	2170	2340
RECOVERY CREDIT ($/Yr)			30	20	20		100	90	80	250	400	400	400
COST EFFECTIVENESS ($/Mg VO removed)			30000	45000	45230		9000	9900	11420	3470	2060	1990	2180

NOTES:

a) Costs are less than $100.

1. Instrumentation: 10% of Base Equipment Cost (BEC).
2. Sales tax and freight: 8% of BEC + Instr.
3. Purchased Equipment Cost (PEC): BEC + Instr. + Sales Tax & Freight.
4. Total Installation Cost (Direct + Indirect): 67% of PEC
5. Total Capital Investment (TCI): PEC + Total Installation Cost
6. Supervision and Admin. Labor: 15% of Direct Labor.
7. Maintenance Labor and Materials: 3% of TCI.
8. Overhead: 60% of Op. Labor + Supv./Adm. + Maint.
9. Property Taxes, Insurance, and Admin. Charges: 4% of TCI.
10. Capital Recovery: 10% over a 15-year service life.

TABLE 5. CARBON ADSORPTION CONTROL COSTS FOR MODEL UNIT CASES NOT ACHIEVING 95% CONTROL WITH CONDENSERS, OPTION 1.

Parameter	Case No.	5	8	9	17	18	19	20	21	25	33	35	36	37
Constituent		MECHL	MEK	MECHL	MECHL	TOL	TCE	MEK	MECHL	MECHL	MECHL	TCE	MEK	MECHL
Flow Rate (acfm)		8.3	8.3	8.3	1.2	1.2	1.2	1.2	1.2	1.2	0.6	0.6	0.6	0.6
Emission Rate (lbs/hr)		4.20	4.20	10.60	0.42	0.42	0.42	0.42	1.20	5.00	0.24	0.24	0.24	1.00
Operating Hours (hrs/yr)		4160	4160	4160	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080
Mole Percent (%)		3.9	4.6	9.8	2.7	2.5	1.7	3.2	7.7	31.9	3.1	2	3.6	12.8
LEL (ppmv)		a	19000	a	a	14000	a	19000	a	a	a	a	19000	a
Carbon Capacity (lbs/1000 lbs)		100	80	100	100	70	150	80	100	100	100	150	80	100
Total Capital Investment (1986 $)		102,540	101,730	97,300	1,050	1,050	1,050	1,050	191,000	103,160	1,050	1,050	1,050	201,530
Annual Operating Costs (1986 $)		40,170	40,480	41,680	18,330	24,830	12,460	22,210	43,130	40,400	10,510	7,890	13,130	43,480
Total Annual Costs (1986 $)		56,430	56,510	56,440	18,500	25,000	12,630	22,380	74,090	56,680	10,680	8,060	13,300	76,180
Recovery Credit ($/yr)		3,400	3,400	8,570	0	0	0	0	430	2,020	0	0	0	400
Cost Effectiveness ($/Mg VO)		7,030	7,040	2,510	49,040	66,270	33,480	59,330	68,290	12,170	49,540	37,350	61,700	84,370

Notes:

a. LEL assumed to be 17500 ppmv.

1. The constituents are methyl ethyl ketone (MEK), methylene chloride (MECHL), toluene (TOL), and 1,1,1 trichloroethane (TCE).
2. The carbon adsorption systems for Cases 8,9,21,25,and 37 involve use of a fixed bed regenerable system.
3. The carbon adsorption systems for Cases 17,18,19,20,33,35,and 36 involve use of carbon cannisters.
4. Carbon cannisters are not regenerated on site and a recovery credit is not appropriate.
5. Costs for carbon adsorption systems were estimated using the EPA/ERB CONTROL COST MANUAL, EPA 450/5-87-001A, Febrary 1987.

RESEARCH TRIANGLE INSTITUTE

Center for Environmental Systems

September 22, 1988

DRAFT

MEMORANDUM

TO: Rick Colyer, EPA/SDB and Bob Lucas, EPA/CPB

FROM: Robert Zerbonia, RTI RAZ

SUBJECT: Costs for Fugitive Emission Control at WSTF/TSDF Model Units

The model unit costs for controlling fugitive emissions at waste solvent treatment facilities (WSTF) and hazardous waste treatment, storage, and disposal facilities (TSDF) are presented in the attached tables. These costs reflect three levels of control. Option 1 involves implementation of a monthly leak detection and repair program for pumps and valves and installation of leakless controls on pressure relief devices, sampling connections, and open-ended lines. Option 2 involves the implementation of a monthly leak detection and repair program for valves (NOTE: All valves at solvent recycling units are considered to be in light liquid service) and installation of leakless equipment for pumps (dual mechanical seals), pressure relief devices, sampling connections, and open-ended lines. Option 3 requires installation of leakless equipment (sealed-bellows valves and dual mechanical seals) on valves and pumps as well as leakless controls on pressure relief devices, sampling connections, and open-ended lines. All costs are presented in January 1986 dollars.

Costs for the monthly leak detection and repair program are based on results of January 1986 runs of the EPA/CPB LOTUS 123 costing program for a leak detection and repair program for pumps, valves, and other potentially leaking sources (see RCRA TSDF Air Emissions Background Technical Memoranda for Proposed Standards, EPA-450/3-86-009, October 1986). Costs for Option 2 control equipment for pump and valves are based on the data contained in Appendix F (Supplemental Information for the Cost Analysis) of the May 1984 Coke Oven By-Products' BID (EPA-450/3-83-016a) and results of a valve and pump manufacturer/vendor survey conducted after proposal.

RAZ/ddf

Attachments

TABLE 1. Cost, Emission Reduction, and Cost Effectiveness of Implementing Option 1 Equipment Leak Controls on the WSTF/TSDF Large Model Unit.

model unit #1 - option 1

EMISSION SOURCE	NUMBER OF SOURCES	ANNUAL EMISS. (Mg/Yr)	CONTROL EFFIC. (%)	EMISSION REDUCTION (Mg/Yr)	CAPITAL COST (1986 $)	ANNUALIZ. COST ($/Yr)	RECOVERY CREDIT (d) ($/Yr)	COST EFFECT. ($/Mg)
PUMP SEALS								
LIGHT LIQUID	15	6.6	61	4.0	880	5,360	1,770	890
HEAVY LIQUID	0	0	0		0			
COMPRESSORS	0	0	100	0.0	0	0	0	NA
FLANGES	0	0	0	0.0	NA	NA	NA	NA
VALVES								
GAS	100	5	73	3.7	1,010	7,130	1,580	100
LIQUID	264	16.4	59	9.7	(e)	(e)	4,260	(e)
RELIEF VALVES								
GAS	9	8.1	100	8.1	34,620	9,840	3,660	760
LIQUID	0	0						
SAMPLING CONNCTN	26	3.5	100	3.5	18,440	4,590	1,580	870
OPEN-ENDED LINES	105	1.5	100	1.5	7,010	1,680	680	670
MONITOR. INSTRUMENT (a,b,c)	NA	NA	NA	NA	6,310	2,370	NA	NA
TOTAL	519	41.1		30.4	68,270	30,970	13,530	570

Notes:

(a) Assume one instrument per plant.
(b) Capital recovery factor is based on 10% interest and 6-yr equipment life.
(c) Maintence, taxes, and insurance = 25% of capital cost.
(d) Assumes approximately $450/Mg credit for recovery.
(e) Total for both gas and liquid.

TABLE 2. Cost, Emission Reduction, and Cost Effectiveness of Implementing Option 1 Equipment Leak Controls on the WSTF/TSDF Medium Model Unit.

model unit #2 - option 1

EMISSION SOURCE	NUMBER OF SOURCES	ANNUAL EMISS. (Mg/Yr)	CONTROL EFFIC. (%)	EMISSION REDUCTION (Mg/Yr)	CAPITAL COST (1986 $)	ANNUALIZ. COST ($/Yr)	RECOVERY CREDIT (d) ($/Yr)	COST EFFECT. ($/Mg)
PUMP SEALS								
LIGHT LIQUID	5	2.2	61	1.3	290	1,790	590	900
HEAVY LIQUID	0	0	0		0			
COMPRESSORS	0	0	100	0.0	0	0	0	NA
FLANGES	0	0	0	0.0	NA	NA	NA	NA
VALVES								
GAS	34	1.7	73	1.2	340	2,380	530	100
LIQUID	87	5.4	59	3.2	(e)	(e)	1,420	(e)
RELIEF VALVES								
GAS	3	2.7	100	2.7	11,540	3,280	1,220	760
LIQUID	0	0						
SAMPLING CONNCTN	9	1.2	100	1.2	6,150	1,530	530	830
OPEN-ENDED LINES	35	0.5	100	0.5	2,340	560	230	660
MONITOR. INSTRUMENT (a,b,c)	NA	NA	NA	NA	6,310	2,370	NA	NA
TOTAL	173	13.7		10.2	26,970	11,910	4,520	730

Notes:

(a) Assume one instrument per plant.
(b) Capital recovery factor is based on 10% interest and 6-yr equipment life.
(c) Maintence, taxes, and insurance = 25% of capital cost.
(d) Assumes approximately $450/Mg credit for recovery.
(e) Total for both gas and liquid.

TABLE 3. Cost, Emission Reduction, and Cost Effectiveness of Implementing Option 1 Equipment Leak Controls on the WSTF/TSDF Small Model Unit.

model unit #3 - option 1

EMISSION SOURCE	NUMBER OF SOURCES	ANNUAL EMISS. (Mg/Yr)	CONTROL EFFIC. (%)	EMISSION REDUCTION (Mg/Yr)	CAPITAL COST (1986 $)	ANNUALIZ. COST ($/Yr)	RECOVERY CREDIT (d) ($/Yr)	COST EFFECT. ($/Mg)
PUMP SEALS								
LIGHT LIQUID	3	1.3	61	0.8	180	1.070	350	910
HEAVY LIQUID	0	0	0		0			
COMPRESSORS	0	0	100	0.0	0	0	0	NA
FLANGES	0	0	0	0.0	NA	NA	NA	NA
VALVES								
GAS	20	1	73	0.7	200	1.430	320	100
LIQUID	52	3.2	59	1.9	(e)	(e)	850	(e)
RELIEF VALVES								
GAS	2	1.8	100	1.8	6.920	1.970	730	690
LIQUID	0	0						
SAMPLING CONNCTN	5	0.7	100	0.7	3.690	920	320	860
OPEN-ENDED LINES	21	0.3	100	0.3	1.400	340	140	670
MONITOR. INSTRUMENT (a.b.c)	NA	NA	NA	NA	6.310	2.370	NA	NA
TOTAL	103	8.3		6.2	18.700	9.100	2.710	870

Notes:

(a) Assume one instrument per plant.
(b) Capital recovery factor is based on 10% interest and 6-yr equipment life.
(c) Maintence, taxes, and insurance = 25% of capital cost.
(d) Assumes approximately $450/Mg credit for recovery.
(e) Total for both gas and liquid.

TABLE 4. Cost, Emission Reduction, and Cost Effectiveness of Implementing Option 2 Equipment Leak Controls on the WSTF/TSDF Large Model Unit.

model unit #1 - option 2

EMISSION SOURCE	NUMBER OF SOURCES	ANNUAL EMISS. (Mg/Yr)	CONTROL EFFIC. (%)	EMISSION REDUCTION (Mg/Yr)	CAPITAL COST (1986 $)	ANNUALIZ. COST ($/Yr)	RECOVERY CREDIT (a) ($/Yr)	COST EFFECT. ($/Mg)
PUMP SEALS (c)								
LIGHT LIQUID	15	6.6	95	6.3	144,750	57,300	2,840	8,640
HEAVY LIQUID	0	0	0		0			
COMPRESSORS	0	0	0	0	0	0	0	NA
FLANGES	0	0	0	0	NA	NA	NA	NA
VALVES (d)								
GAS	100	5.1	73	3.7	1,020	7,140	1,670	90
LIQUID	264	16.2	59	9.6	(b)	(b)	4,300	(b)
RELIEF VALVES								
GAS	9	8.1	100	8.1	34,620	9,840	3,660	760
LIQUID	0	0						
SAMPLING CONNCTN	26	3.6	100	3.6	18,440	4,590	1,580	840
OPEN-ENDED LINES	105	1.5	100	1.5	7,010	1,680	680	670
MONITOR. INSTRUMENT	NA	NA	NA	NA	6,310	2,370	NA	NA
TOTAL	519	41.1		32.8	212,150	82,920	14,730	2,080

Notes:

NA = Not Applicable

(a) Assumes approximately $450/Mg credit for recovery.

(b) Total for both gas and liquid.

(c) Based on installation of dual mechanical seals with barrier fluid system and degassing vents.

(d) Based on LDAR for valves.

TABLE 5. Cost, Emission Reduction, and Cost Effectiveness of Implementing Option 2 Equipment Leak Controls on the WSTF/TSDF Medium Model Unit.

model unit #2 - option 2

EMISSION SOURCE	NUMBER OF SOURCES	ANNUAL EMISS. (Mg/Yr)	CONTROL EFFIC. (%)	EMISSION REDUCTION (Mg/Yr)	CAPITAL COST (1986 $)	ANNUALIZ. COST ($/Yr)	RECOVERY CREDIT(a) ($/Yr)	COST EFFECT. ($/Mg)
PUMP SEALS (c)								
LIGHT LIQUID	5	2.2	95	2.1	48,250	19,100	950	8,640
HEAVY LIQUID	0	0	0		0			
COMPRESSORS	0	0	0	0	0	0	0	NA
FLANGES	0	0	0	0	NA	NA	NA	NA
VALVES (d)								
GAS	34	1.7	73	1.2	340	2,380	560	90
LIQUID	87	5.4	59	3.2	(b)	(b)	1,430	(b)
RELIEF VALVES								
GAS	3	2.7	100	2.7	11,540	3,280	1,220	760
LIQUID	0	0						
SAMPLING CONNCTN	9	1.2	100	1.2	6,150	1,530	530	830
OPEN-ENDED LINES	35	0.5	100	0.5	2,340	560	230	560
MONITOR. INSTRUMENT	NA	NA	NA	NA	6,310	2,370	NA	NA
TOTAL	173	13.7		10.9	74,930	29,220	4,920	2,230

Notes:

NA = Not Applicable

(a) Assumes approximately $450/Mg credit for recovery.

(b) Total for both gas and liquid.

(c) Based on installation of dual mechanical seals with barrier fluid system and degassing vents.

(d) Based on LDAR for valves.

TABLE 6. Cost, Emission Reduction, and Cost Effectiveness of Implementing Option 2 Equipment Leak Controls on the WSTF/TSDF Small Model Unit.

model unit #3 - option 2

EMISSION SOURCE	NUMBER OF SOURCES	ANNUAL EMISS. (Mg/Yr)	CONTROL EFFIC. (%)	EMISSION REDUCTION (Mg/Yr)	CAPITAL COST (1986 $)	ANNUALIZ. COST ($/Yr)	RECOVERY CREDIT (a) ($/Yr)	COST EFFECT. ($/Mg)
PUMP SEALS (c)								
LIGHT LIQUID	3	1.3	95	1.2	28,950	11,460	540	9,100
HEAVY LIQUID	0	0	0		0			
COMPRESSORS	0	0	0	0	0	0	0	NA
FLANGES	0	0	0	0	NA	NA	NA	NA
VALVES (d)								
GAS	20	1	73	0.7	200	1,430	330	100
LIQUID	52	3.2	59	1.9	(b)	(b)	850	(c)
RELIEF VALVES								
GAS	2	1.8	100	1.8	6,920	1,970	730	690
LIQUID	0	0						
SAMPLING CONNCTN	5	0.7	100	0.7	3,690	920	320	860
OPEN-ENDED LINES	21	0.3	100	0.3	1,400	340	140	670
MONITOR. INSTRUMENT	NA	NA	NA	NA	6,310	2,370	NA	NA
TOTAL	103	8.3		6.6	47,470	18,490	2,910	2,360

Notes:

NA = Not Applicable

(a) Assumes approximately $450/Mg credit for recovery.

(b) Total for both gas and liquid.

(c) Based on installation of dual mechanical seals with barrier fluid system and degassing vents.

(d) Based on LDAR for valves.

TABLE 7. Cost, Emission Reduction, and Cost Effectiveness of Implementing Option 3 Equipment Leak Controls on the WSTF/TSDF Large Model Unit.

model unit #1 - option 3

EMISSION SOURCE	NUMBER OF SOURCES	ANNUAL EMISS. (Mg/Yr)	CONTROL EFFIC. (%)	EMISSION REDUCTION (Mg/Yr)	CAPITAL COST (1986 $)	ANNUALIZ. COST ($/Yr)	RECOVERY CREDIT(a) ($/Yr)	COST EFFECT. ($/Mg)
PUMP SEALS (c)								
LIGHT LIQUID	15	6.6	95	6.3	144,750	57,300	2,840	8,640
HEAVY LIQUID	0	0	0		0			
COMPRESSORS	0	0	100	0	0	0	0	NA
FLANGES	0	0	0	0	NA	NA	NA	NA
VALVES (d)								
GAS	100	5.1	100	5.1	2,002,730	504,870	2,300	23,030
LIQUID	264	16.4	100	16.4	(b)	(b)	7,380	(b)
RELIEF VALVES								
GAS	9	8.1	100	8.1	34,620	9,840	3,660	760
LIQUID	0	0						
SAMPLING CONNCTN	26	3.5	100	3.5	18,440	4,590	1,580	860
OPEN-ENDED LINES	105	1.5	100	1.5	7,010	1,680	680	670
MONITOR. INSTRUMENT	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	519	41.1		40.9	2,207,550	578,280	18,440	13,690

Notes:

NA = Not Applicable
(a) Assumes approximately $450/Mg credit for recovery.
(b) Total for both gas and liquid.
(c) Based on installation of dual mechanical seals with barrier fluid system and degassing vents.
(d) Based on installation of sealed-bellows valves.

TABLE 8. Cost, Emission Reduction, and Cost Effectiveness of Implementing Option 3 Equipment Leak Controls on the WSTF/TSDF Medium Model Unit.

model unit #2 - option 3

EMISSION SOURCE	NUMBER OF SOURCES	ANNUAL EMISS. (Mg/Yr)	CONTROL EFFIC. (%)	EMISSION REDUCTION (Mg/Yr)	CAPITAL COST (1986 $)	ANNUALIZ. COST ($/Yr)	RECOVERY CREDIT (a) ($/Yr)	COST EFFECT. ($/Mg)
PUMP SEALS (c)								
LIGHT LIQUID	5	2.2	95	2.1	48,250	19,100	950	8,640
HEAVY LIQUID	0	0	0		0			
COMPRESSORS	0	0	100	0	0	0	0	NA
FLANGES	0	0	0	0	NA	NA	NA	NA
VALVES (d)								
GAS	34	1.7	100	1.7	665,740	167,830	770	23,190
LIQUID	87	5.4	100	5.4	(b)	(b)	2,430	(b)
RELIEF VALVES								
GAS	3	2.7	100	2.7	11,540	3,280	1,220	760
LIQUID	0	0						
SAMPLING CONNCTN	9	1.2	100	1.2	6,150	1,530	530	830
OPEN-ENDED LINES	35	0.5	100	0.5	2,340	560	230	660
MONITOR. INSTRUMENT	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	173	13.7		13.6	734,020	192,300	6,130	13,690

Notes:

NA = Not Applicable
(a) Assumes approximately $450/Mg credit for recovery.
(b) Total for both gas and liquid.
(c) Based on installation of dual mechanical seals with barrier fluid system and degassing vents.
(d) Based on installation of sealed-bellows valves.

TABLE 9. Cost, Emission Reduction, Cost Effectiveness of Implementing Option 3 Equipment Leak Controls on the WSTF/TSDF Small Model Unit.

model unit #3 - option 3

EMISSION SOURCE	NUMBER OF SOURCES	ANNUAL EMISS. (Mg/Yr)	CONTROL EFFIC. (%)	EMISSION REDUCTION (Mg/Yr)	CAPITAL COST (1986 $)	ANNUALIZ. COST ($/Yr)	RECOVERY CREDIT (a) ($/Yr)	COST EFFECT. ($/Mg)
PUMP SEALS (c)								
LIGHT LIQUID	3	1.3	95	1.2	28,950	11,460	540	9,100
HEAVY LIQUID	0	0	0		0			
COMPRESSORS	0	0	100	0	0	0	0	NA
FLANGES	0	0	0	0	NA	NA	NA	NA
VALVES (d)								
GAS	20	1	100	1.0	396,140	99,860	450	23,330
LIQUID	52	3.2	100	3.2	(b)	(b)	1,440	(b)
RELIEF VALVES								
GAS	2	1.8	100	1.8	6,920	1,970	730	690
LIQUID	0	0						
SAMPLING CONNCTN	5	0.7	100	0.7	3,690	920	320	860
OPEN-ENDED LINES	21	0.3	100	0.3	1,400	340	140	670
MONITOR. INSTRUMENT	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	103	8.3		8.2	437,100	114,550	3,620	13,530

Notes:

NA = Not Applicable
(a) Assumes approximately $450/Mg credit for recovery.
(b) Total for both gas and liquid.
(c) Based on installation of dual mechanical seals with barrier fluid system and degassing vents.
(d) Based on installation of sealed-bellows valves.

RESEARCH TRIANGLE INSTITUTE

Center for Environmental Systems

September 28, 1988

DRAFT

MEMORANDUM

TO: Rick Colyer, EPA/SDB and Bob Lucas, EPA/CPB

FROM: Robert Zerbonia, RTI

SUBJECT: Evaluation of Incineration as a Process Vent Control Technique

The proposal analysis included an evaluation of the use of incineration (halogenated compounds)/flares (non-halogenated compounds) as a regulatory alternative achieving 98 percent control. This level of control was not proposed because it resulted in minimal risk reduction at a significantly greater control cost than condensation.

The proposal analysis incineration control costs are based on the application of the lowest size vapor incinerator (1 m^3) at 98 percent control efficiency to process vent streams with 7 lb/hr and 75 lb/hr of organic emissions. For the post proposal model units, the capital costs are the same (updated from June 1985 to January 1986) and the fuel-use component of the operating costs were factored based on the organic content of the vent stream. Table 1 presents estimates of the capital and annualized costs of vapor incinerators for the (post proposal) model unit cases. In estimating nationwide costs, the number of facilities reporting on-site liquid hazardous waste incinerators in the industry profile could be accounted for. The 1987 Screener data shows 190 facilities with liquids incineration on site; review of the first half of the 1987 National TSDR Survey database indicates that only 137 of the TSDF surveyed have incinerators onsite. As input to the analysis of risk reduction, a dBase file could be created for PAB with revised emission rates and vent stream characteristics (temperature, flow rates, stack heights, etc.). It would also be possible to approximate the risk reduction achieved through use of an incinerator rather than a condenser/carbon adsorber by proportioning the risk based on the ratio of control efficiencies for the options. Stack heights and flow rates would be similar for both control technologies. Exhaust gas temperature could be somewhat higher for the incinerator; however, this may not necessarily be the case if the incinerator exhaust gases undergo any sort of processing such as heat recovery or NO_x or particulate controls.

Regarding the control efficiency, we feel that for this regulation to be promulgated under RCRA, the vent stream would not necessarily be classified as a hazardous waste, requiring an incinerator that achieves 99.99 percent destruction efficiency. Recent guidance from EPA's Office of General Council stated that noncontainerized gases emitted from hazardous wastes are not themselves hazardous wastes, because the statute implicitly excludes them. EPA does however have the authority to regulate them as emissions from hazardous wastes. Therefore, the revised analysis will examine vapor incineration at a control efficiency of 98% as the bases for process vent controls. Please call me to discuss the inclusion of incineration in the analysis of process vent control techniques.

RAZ/ddf

TABLE 1. CAPITAL AND ANNUALIZED COSTS OF INCINERATORS FOR MODEL UNIT CASES

Model Unit Size	Model Unit Case No.	Capital Cost,[a] 1986 $	Annual cost,[b] $/yr
large	1 thru 4	211,000	305,000
large	5 thru 8	211,000	171,000
large	9 thru 12	211,000	163,000
medium	13 thru 16	211,000	275,000
medium	17 thru 20	211,000	171,000
medium	21 thru 24	211,000	125,000
medium	25 thru 28	211,000	106,000
small	29 thru 32	211,000	471,000
small	33 thru 36	211,000	224,000
small	37 thru 40	211,000	130,000

[a] Incinerator system costs include 1 m^3 combustion chamber, 150 ft duct work, fan, stack and quench/scrub system. It is unknown if the system includes a heat exchanger.

[b] The large model units operate 4,160 hr/yr, the same number of hours used in estimating operating costs for the proposal cost analysis. The medium and small model units operate 2,080 hrs/yr, therefore, operating costs were halved before the fuel-use component was factored based on the organic content of the vent stream.

RESEARCH TRIANGLE INSTITUTE

Center for Environmental Systems

DRAFT

January 6, 1989

MEMORANDUM

TO: Rick Colyer, SDB, and Robert Lucas, CPB

FROM: Robert Zerbonia, RTI

SUBJECT: Results of the Source Assessment Model (SAM) Runs for TSDF Equipment Leaks

The SAM was used to estimate nationwide uncontrolled and controlled organic emissions from TSDF equipment leaks. Additional SAM runs were made to estimate total nationwide cancer incidence from equipment leak emissions and the nationwide costs of controlling these emissions through implementation of a leak detection and repair program (LDAR) as well as certain equipment requirements. The SAM runs were structured to estimate equipment leak emissions from TSDF waste streams of 10 percent or greater total organics and to reflect the estimated increase in waste managed due to implementation of EPA/OSW's land disposal restrictions. The two control cases run to estimate emissions and costs are: Case A, LDAR for both pump and valves in light liquid service and equipment requirements for other sources; and Case B, LDAR for valves and a dual mechanical seal requirement for pumps in light liquid service, with the same equipment requirements for other sources.

Because the SAM (and the accompanying data bases) was not designed to incorporate waste solvent recycling units among the hazardous waste management units analyzed, equipment leaks from these units were estimated separately. Nationwide organic emissions from equipment leaks are estimated at 18,410 Mg/yr for the uncontrolled case for all TSDF waste management units excluding recyclers. With recycling equipment leaks included, the total nationwide emissions from equipment leaks is 26,240 Mg/yr, uncontrolled. For control Case A, nationwide emissions from equipment leaks are estimated at 5,289 Mg/yr with LDAR for all TSDF equipment excluding recycling units. With recycling unit equipment leaks included, the total nationwide emissions from equipment leaks are 7,189 Mg/yr for Case A. Under the more stringent controls which include dual mechanical seals for pumps, nationwide emissions from TSDF equipment leaks are estimated at 4,569 Mg/yr excluding recycling units which are not a part of the SAM estimates. With recycling equipment leaks included, the total nationwide emissions from equipment leaks are 6,077 Mg/yr for Case B. Tables 1, 2, and 3 present the results of the SAM equipment leak emission estimates for the uncontrolled case, Case A, and Case B respectively. Attachment 1 is a summary of the procedure used by the SAM to estimate emissions from equipment leaks. The results of the SAM runs to estimate control costs are presented in Tables 4 and 5 for control Case A. Table 3 presents the costs for Case B. For Case A, total nationwide capital costs are estimated at $113.2 million, excluding control of recyclers. With recyclers, the total capital costs are estimated at $126.6. Total annual costs for equipment leak controls at all TSDF waste management units other than recycling units were estimated at $29.3 million per year. With recycling units, the total nationwide annual costs are $32.9 million/yr. For Case B, the capital costs are $173.8 million without recyclers and $211.7 million with recycling units. The total annual costs are $41.8 million/yr without recyclers and $54.1 million/yr with recycling units included in the analysis of Case B. Attachment 2 provides a summary of the procedure developed for the SAM to estimate control costs for equipment leaks at TSDF.

RAZ/ddf

Table 1. Uncontrolled Equipment Leak Emissions (Excluding Recyclers) as Estimated by the SAM

Air Emissions

TOP 50 FACILITIES NATIONWIDE
EMISSIONS IN 1000 Mg/yr

Fugitives only
Total across subunits

ID	Facility	S01	S02	S03	S04	T01	T02	T03	T04	D79	D80	D81	D83	TSL	Total	Cumul
1		0.1261E-01	1.127	0.0000E+00	0.0000E+00	0.9127E-02	0.0000E+00	1.663	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1274	2.939	15.96%
2		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.160	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.160	27.69%
3		1.200	0.4233	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2604	1.884	37.92%
4		0.2526	0.0000E+00	0.0000E+00	0.0000E+00	0.2626E-03	0.0000E+00	0.0000E+00	0.1253	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.270	1.802	47.71%
5		0.9216	0.3118	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1987	1.432	55.46%
6		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5175E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7218	0.7735	59.66%
7		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4259	62.13%
8		0.2540	0.7630E-01	0.0000E+00	0.0000E+00	0.2037E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4213E-01	0.3874	64.24%
9		0.1272	0.4664E-01	0.0000E+00	0.0000E+00	0.2583E-05	0.0000E+00	0.6464E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7918E-01	0.2425	65.56%
10		0.2343	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2343	66.83%
11		0.2044	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2044	67.94%
12		0.1011	0.3662E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2546E-01	0.0000E+00	0.2936E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1662	68.84%
13		0.6021E-03	0.7816E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1151	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1933	70.05%
14		0.3820E-01	0.5023E-01	0.0000E+00	0.0000E+00	0.5340E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6027E-01	0.1492	71.02%
15		0.1779	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4432E-05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1779	72.00%
16		0.1711	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1711	72.93%
17		0.1288	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1288	73.63%
18		0.7447E-01	0.2663E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1638E-01	0.1175	74.27%
19		0.7813E-01	0.2215E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1366E-01	0.1140	74.89%
20		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1602E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1077	75.51%
21		0.6673E-01	0.2398E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1298E-01	0.1036	76.07%
22		0.6363E-01	0.2295E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1432E-01	0.1011	76.62%
23		0.9876E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9876E-01	77.16%
24		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9722E-01	77.69%
25		0.9185E-01	0.1333E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8587E-04	0.9207E-01	78.19%
26		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6406E-03	0.0000E+00	0.8258E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6159E-02	0.8935E-01	78.67%
27		0.8765E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8765E-01	79.15%
28		0.7513E-01	0.3670E-06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2943E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7585E-01	79.64%
29		0.4286E-01	0.1544E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2306E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8136E-01	80.08%
30		0.4632E-01	0.1661E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1243E-01	0.4854E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5106E-02	0.8095E-01	80.53%
31		0.4384E-01	0.1577E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1289E-01	0.4563E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4789E-02	0.7713E-01	80.94%
32		0.0000E+00	0.3904E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1584E-01	0.2145E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7644E-01	81.36%
33		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1380E-02	0.0000E+00	0.5986E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1561E-01	0.7685E-01	81.77%
34		0.3914E-01	0.1298E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9682E-02	0.6177E-01	82.11%
35		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6087E-01	82.44%
36		0.5625E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5625E-01	82.74%
37		0.3294E-01	0.1170E-01	0.0000E+00	0.0000E+00	0.1173E-03	0.0000E+00	0.7576E-02	0.1550E-05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1466E-03	0.5280E-01	83.03%
38		0.3421E-01	0.1237E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7975E-02	0.5456E-01	83.34%
39		0.5402E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5402E-01	83.64%
40		0.4316E-01	0.6503E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4002E-02	0.5366E-01	83.93%
41		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4746E-01	0.0000E+00	0.6046E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5352E-01	84.22%
42		0.5351E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5351E-01	84.51%
43		0.0000E+00	0.5959E-03	0.0000E+00	0.0000E+00	0.1513E-01	0.0000E+00	0.0000E+00	0.2995E-01	0.3070E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.4043E-04	0.4787E-01	84.77%
44		0.4661E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4661E-01	85.02%
45		0.2798E-01	0.1006E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6285E-02	0.4432E-01	85.26%
46		0.4273E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4273E-01	85.49%
47		0.3980E-04	0.3738E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2116E-05	0.2507E-08	0.3081E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.1782E-03	0.4067E-01	85.71%
48		0.6094E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3887E-01	85.92%
49		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3843E-01	86.13%
50		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2024E-03	0.0000E+00	0.3607E-01	0.1058E-04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2047E-02	0.3836E-01	86.34%
Total Top 50		4.977	2.460	0.0000E+00	0.0000E+00	0.9118E-01	0.4834E-06	4.343	0.1426	0.6427E-01	0.0000E+00	0.0000E+00	0.0000E+00	2.884	15.90	
Total All Fac		6.062	2.932	0.0000E+00	0.8770E-04	0.8725E-01	0.1664E-05	4.618	0.1585	0.1148	0.0000E+00	0.0000E+00	0.6864E-09	3.225	18.41	
% Distribution		32.92%	15.93%	0.00%	0.00%	0.47%	0.00%	25.08%	0.86%	0.62%	0.00%	0.00%	0.00%	17.51%		

Table 1. Uncontrolled Equipment Leak Emissions (Excluding Recyclers) as Estimated by the SAM

Air Emissions

TOP 50 FACILITIES NATIONWIDE
EMISSIONS IN 1000 Mg/yr

Fugitives only
Total across subunits

NO	Facility	LTR	INC	PT1	PT2	PT3	PT4	PT5	x000	FOP	LDR	XXX	XXX	XXX	Total	Cumul
1		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.930	15.92%
2		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.180	27.76%
3		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.884	37.98%
4		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1461	0.0000E+00	0.0000E+00	0.0000E+00	1.800	47.71%
5		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.406	55.46%
6		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7729	59.66%
7		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4290	0.0000E+00	0.0000E+00	0.0000E+00	0.4290	62.13%
8		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3874	64.24%
9		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2425	65.56%
10		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2345	66.83%
11		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2044	67.94%
12		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1962	69.00%
13		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1933	70.05%
14		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1852	71.06%
15		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6622E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.1779	72.03%
16		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1711	72.96%
17		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1392	73.72%
18		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1175	74.37%
19		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1089	74.96%
20		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1077	0.0000E+00	0.0000E+00	0.0000E+00	0.1077	75.54%
21		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1050	76.12%
22		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1011	76.67%
23		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9876E-01	77.20%
24		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9722E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.9722E-01	77.73%
25		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9097E-01	78.22%
26		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8932E-01	78.72%
27		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8765E-01	79.19%
28		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7620E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.8302E-01	79.64%
29		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8136E-01	80.08%
30		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8085E-01	80.52%
31		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7713E-01	80.94%
32		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7644E-01	81.36%
33		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7609E-01	81.77%
34		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6177E-01	82.11%
35		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6087E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.6087E-01	82.44%
36		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5625E-01	82.74%
37		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2935E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.5598E-01	83.05%
38		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5456E-01	83.34%
39		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5460E-01	83.64%
40		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5364E-01	83.93%
41		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5350E-01	84.22%
42		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5351E-01	84.51%
43		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7668E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.4727E-01	84.77%
44		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4664E-01	85.02%
45		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4432E-01	85.26%
46		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4273E-01	85.49%
47		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4067E-01	85.71%
48		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3278E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.3807E-01	85.92%
49		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3843E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.3843E-01	86.13%
50		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3826E-01	86.34%
	Total Top 50	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.049	0.0000E+00	0.0000E+00	0.0000E+00	15.90	
	Total All Fac	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.216	0.0000E+00	0.0000E+00	0.0000E+00	18.41	
	% Distribution	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	6.60%	0.00%	0.00%	0.00%		

Air Emissions

Table 2. Equipment Leak Emission for Control Case A (Excluding Recyclers) as Estimated by the SAM

TOP 50 FACILITIES NATIONWIDE
EMISSIONS IN 1000 Mg/yr

Fugitives only
Total across subunits

##	Facility	S01	S02	S03	S04	T01	T02	T03	T04	D79	D80	D81	D83	TRL	Total	Cumul
1		0.3276E-02	0.3339	0.0000E+00	0.0000E+00	0.2712E-02	0.0000E+00	0.4932	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3704E-01	0.8710	16.47%
2		0.3564	0.1262	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7759E-01	0.5602	27.06%
3		0.7454E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.7111E-04	0.0000E+00	0.0000E+00	0.3702E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3797	0.5367	37.17%
4		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5335	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5335	47.26%
5		0.2738	0.5285E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5741E-01	0.4241	55.28%
6		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1537E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2146	0.2299	59.63%
7		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1349	62.18%
8		0.7711E-01	0.2331E-01	0.0000E+00	0.0000E+00	0.6068E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1257E-01	0.1136	64.32%
9		0.3777E-01	0.1386E-01	0.0000E+00	0.0000E+00	0.1067E-05	0.0000E+00	0.2045E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2351E-04	0.7211E-01	65.69%
10		0.6965E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6965E-01	67.00%
11		0.5914E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5914E-01	68.12%
12		0.1320E-05	0.2322E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3423E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5746E-01	69.21%
13		0.1135E-01	0.2631E-01	0.0000E+00	0.0000E+00	0.1583E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1793E-01	0.5629E-01	70.27%
14		0.2862E-01	0.1037E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1574E-01	0.0000E+00	0.8380E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5557E-01	71.32%
15		0.5084E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5084E-01	72.28%
16		0.2904E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1059E-06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4579E-01	73.15%
17		0.4125E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4125E-01	73.93%
18		0.2212E-01	0.7526E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4881E-02	0.3453E-01	74.59%
19		0.2129E-01	0.6543E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4037E-02	0.3187E-01	75.19%
20		0.1983E-01	0.7140E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4458E-02	0.3146E-01	75.79%
21		0.2934E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2934E-01	76.34%
22		0.1847E-01	0.6649E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4160E-02	0.2928E-01	76.90%
23		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2899E-01	77.44%
24		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3518E-10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2855E-01	77.98%
25		0.2714E-01	0.2923E-04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1082E-04	0.2719E-01	78.50%
26		0.2504E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2604E-01	78.99%
27		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1903E-03	0.0000E+00	0.2358E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1829E-02	0.2561E-01	79.47%
28		0.2208E-01	0.8044E-07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8779E-04	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2443E-01	79.94%
29		0.1376E-01	0.4946E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3704E-02	0.1446E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1521E-02	0.2408E-01	80.39%
30		0.1302E-01	0.4693E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3658E-02	0.1341E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1427E-02	0.2294E-01	80.82%
31		0.0000E+00	0.1161E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4709E-02	0.6386E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2270E-01	81.25%
32		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4097E-03	0.0000E+00	0.1753E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4634E-02	0.2257E-01	81.68%
33		0.1185E-01	0.4276E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6420E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2255E-01	82.11%
34		0.1164E-01	0.4162E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2563E-02	0.1837E-01	82.45%
35		0.1671E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1671E-01	82.77%
36		0.9770E-02	0.3501E-02	0.0000E+00	0.0000E+00	0.3478E-04	0.0000E+00	0.2376E-02	0.5681E-07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4178E-04	0.1660E-01	83.08%
37		0.1016E-01	0.3681E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2377E-02	0.1621E-01	83.39%
38		0.1605E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1605E-01	83.69%
39		0.1282E-01	0.1536E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1195E-02	0.1555E-01	84.00%
40		0.1590E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1590E-01	84.30%
41		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1389E-01	0.0000E+00	0.1326E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1521E-01	84.58%
42		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1507E-01	84.87%
43		0.0000E+00	0.1770E-03	0.0000E+00	0.0000E+00	0.4456E-02	0.0000E+00	0.0000E+00	0.8905E-05	0.9120E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.1435E-04	0.1404E-01	85.13%
44		0.8227E-02	0.2964E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1853E-02	0.1304E-01	85.38%
45		0.1270E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1270E-01	85.62%
46		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1149E-01	85.84%
47		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6014E-04	0.0000E+00	0.1063E-01	0.3141E-05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6080E-03	0.1136E-01	86.05%
48		0.0000E+00	0.6875E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4299E-02	0.1117E-01	86.26%
49		0.6845E-02	0.2449E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1530E-02	0.1082E-01	86.47%
50		0.6645E-02	0.2382E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1477E-02	0.1050E-01	86.67%
Total Top 50		1.464	0.7324	0.0000E+00	0.0000E+00	0.2411E-01	0.1060E-06	1.179	0.4230E-01	0.1767E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.8475	4.584	
Total All Fac		1.762	0.8648	0.0000E+00	0.2455E-04	0.2590E-01	0.4462E-06	1.253	0.4707E-01	0.3180E-01	0.0000E+00	0.0000E+00	0.1504E-09	0.9575	5.289	
% Distribution		33.31%	16.35%	0.00%	0.00%	0.49%	0.00%	23.68%	0.89%	0.60%	0.00%	0.00%	0.00%	18.10%		

Air Emissions

Table 2. Equipment Leak Emission for Control Case A (Excluding Recyclers) as Estimated by the SAM

TOP 50 FACILITIES NATIONWIDE
EMISSIONS IN 1000 Mg/yr

Fugitives only
Total across subunits

##	Facility	LTR	INC	PT1	PT2	PT3	PT4	PT5	xSO2	FIP	LBR	XXX	XXX	XXX	Total	Cumul
1		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8710	16.47%
2		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5602	27.06%
3		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4325E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.5247	37.17%
4		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5335	47.26%
5		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4241	55.28%
6		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2299	59.63%
7		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1349	0.0000E+00	0.0000E+00	0.0000E+00	0.1349	62.18%
8		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1136	64.32%
9		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7011E-01	65.65%
10		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6965E-01	67.00%
11		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5914E-01	68.12%
12		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5746E-01	69.21%
13		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5624E-01	70.27%
14		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5557E-01	71.32%
15		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5094E-01	72.28%
16		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1774E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.4579E-01	73.15%
17		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4125E-01	73.93%
18		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3493E-01	74.59%
19		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3187E-01	75.19%
20		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3146E-01	75.79%
21		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2934E-01	76.34%
22		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2928E-01	76.90%
23		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2899E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.2899E-01	77.44%
24		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2855E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.2855E-01	77.98%
25		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2719E-01	78.50%
26		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2604E-01	78.99%
27		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2561E-01	79.47%
28		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2268E-02	0.0000E+00	0.0000E+00	0.0000E+00	0.2443E-01	79.94%
29		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2408E-01	80.39%
30		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2294E-01	80.83%
31		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2270E-01	81.25%
32		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2257E-01	81.68%
33		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2252E-01	82.11%
34		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1837E-01	82.45%
35		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1671E-01	82.77%
36		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8804E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.1660E-01	83.08%
37		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1621E-01	83.39%
38		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1605E-01	83.69%
39		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1592E-01	84.00%
40		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1550E-01	84.30%
41		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1521E-01	84.58%
42		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1507E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.1507E-01	84.87%
43		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2290E-03	0.0000E+00	0.0000E+00	0.0000E+00	0.1474E-01	85.13%
44		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1394E-01	85.38%
45		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1270E-01	85.62%
46		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1140E-01	0.0000E+00	0.0000E+00	0.0000E+00	0.1140E-01	85.84%
47		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1136E-01	86.05%
48		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1117E-01	86.26%
49		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1083E-01	86.47%
50		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1050E-01	86.67%
	Total Top 50	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2832	0.0000E+00	0.0000E+00	0.0000E+00	4.584	
	Total All Fac	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3474	0.0000E+00	0.0000E+00	0.0000E+00	5.289	
	% Distribution	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.57%	0.00%	0.00%	0.00%		

Table 3. Emissions, Total Capital Costs, and Total Annual Costs for Equipment Leaks Under Control Case B.

06-Jan-89

Fugitive Emissions, TCI and TAC for VO >10%
Control: Altern. B

#	PROCESS	EMISSIONS MG/YR	TCI $	TAC $/YR
1	S01	1.508E+03	4.655E+07	1.183E+07
2	S02	7.411E+02	3.548E+07	8.168E+06
3	S03	0.000E+00	0.000E+00	0.000E+00
4	S04	2.163E-02	1.117E+04	2.303E+03
5	T01	2.214E+01	1.402E+06	3.457E+05
6	T02	4.015E-04	1.409E+02	2.941E+01
7	T03	1.114E+03	5.355E+07	1.182E+07
8	T04	4.022E+01	1.738E+06	4.894E+05
9	D79	2.751E+01	2.309E+06	5.115E+05
10	D80	0.000E+00	0.000E+00	0.000E+00
11	D81	0.000E+00	0.000E+00	0.000E+00
12	D83	1.504E-07	1.865E+01	3.734E+00
13	THL	8.182E+02	2.183E+07	5.919E+06
14	LTA	0.000E+00	0.000E+00	0.000E+00
15	INC	0.000E+00	0.000E+00	0.000E+00
16	PT1	0.000E+00	0.000E+00	0.000E+00
17	PT2	0.000E+00	0.000E+00	0.000E+00
18	PT3	0.000E+00	0.000E+00	0.000E+00
19	PT4	0.000E+00	0.000E+00	0.000E+00
20	PT5	0.000E+00	0.000E+00	0.000E+00
21	XS02	0.000E+00	0.000E+00	0.000E+00
22	FXP	0.000E+00	0.000E+00	0.000E+00
23	LDR	2.974E+02	1.097E+07	2.733E+06
	TOTAL	4.569E+03	1.738E+08	4.182E+07

NOTE: Does not include recycling units

Total Capital Investment

Table 4. Total Capital Cost for Equipment Leak Control Case A (Excluding Recyclers)

TOP 50 FACILITIES NATIONWIDE
COST IN $

Fugitives only
Total across submits

##	Facility	S01	S02	S03	S04	T01	T02	T03	T04	079	080	081	083	TNL	Total	Cum%
1		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3581E+08	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3581E+08	31.64%
2		0.0000E+00	0.1734E+08	0.0000E+00	0.0000E+00	0.6604E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.1298E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1929E+08	48.68%
3		0.7798E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7798E+07	55.56%
4		0.7606E+05	0.2905E+07	0.0000E+00	0.0000E+00	0.1346E+05	0.0000E+00	0.4508E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1957E+06	0.7698E+07	62.37%
5		0.2873E+07	0.1016E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6415E+06	0.4533E+07	66.37%
6		0.4033E+06	0.0000E+00	0.0000E+00	0.0000E+00	731.2	0.0000E+00	0.0000E+00	0.3244E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3611E+07	0.4338E+07	70.19%
7		0.1487E+07	0.4973E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3152E+06	0.2300E+07	72.23%
8		0.1490E+07	0.5509E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3524E+05	0.4775E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2124E+07	74.10%
9		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1885E+07	75.77%
10		0.6448E+06	0.2352E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3832E+06	0.0000E+00	0.2023E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1283E+07	76.91%
11		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1270E+07	78.03%
12		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8253E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1109E+07	0.1192E+07	79.08%
13		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1577.	0.0000E+00	0.1046E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2061E+05	0.1068E+07	80.02%
14		0.6683E+06	0.1255E+06	0.0000E+00	0.0000E+00	3761.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8015E+05	0.8867E+06	80.81%
15		0.4707E+06	0.1650E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1098E+06	0.7445E+06	81.46%
16		0.6119E+06	0.3711E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2533E+05	0.6744E+06	82.06%
17		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5264E+06	82.53%
18		0.2864E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	33.97	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4679E+06	82.94%
19		458.4	0.2724E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1865E+06	0.4594E+06	83.34%
20		0.4316E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4316E+06	83.73%
21		1231.	0.1648E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2570E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4230E+06	84.10%
22		0.8048E+05	0.1965E+06	0.0000E+00	0.0000E+00	1136.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1375E+06	0.4156E+06	84.47%
23		0.2181E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3467E+06	84.77%
24		140.8	0.2930E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	750.9	0.1079E-01	0.2494E+05	0.0000E+00	0.0000E+00	0.0000E+00	265.2	0.3181E+06	85.05%
25		0.1607E+06	0.6573E+05	0.0000E+00	0.0000E+00	5.298	0.0000E+00	0.6778E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	120.3	0.3143E+06	85.33%
26		0.3136E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3136E+06	85.61%
27		0.1705E+06	0.5926E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3742E+05	0.2672E+06	85.85%
28		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.322	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2640E+06	86.08%
29		0.1584E+06	0.5523E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3502E+05	0.2487E+06	86.30%
30		0.2331E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2331E+06	86.50%
31		0.2328E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2328E+06	86.71%
32		0.1822E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1822E+06	86.87%
33		0.9567E+05	0.3257E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5110E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1793E+06	87.03%
34		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1767E+06	87.19%
35		0.1758E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1758E+06	87.34%
36		0.1097E+06	0.3745E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2396E+05	0.1711E+06	87.49%
37		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1620E+06	87.63%
38		0.1426E+06	89.72	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	436.3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1557E+06	87.77%
39		0.9249E+05	0.3127E+05	0.0000E+00	0.0000E+00	659.5	0.0000E+00	0.1224E+05	0.6000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7488.	0.1490E+06	87.90%
40		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1423E+06	88.03%
41		0.8885E+05	0.2993E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1941E+05	0.1382E+06	88.15%
42		0.8448E+05	0.2850E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1807.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1533E+05	0.1341E+06	88.27%
43		0.1312E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1312E+06	88.39%
44		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1309E+06	88.50%
45		0.7584E+05	0.2520E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2033E+05	725.7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7726.	0.1298E+06	88.62%
46		0.0000E+00	0.6406E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2611E+05	0.3524E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1254E+06	88.73%
47		0.1251E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1251E+06	88.84%
48		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8394.	0.0000E+00	0.8912E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2556E+05	0.1231E+06	88.95%
49		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7613E+05	0.0000E+00	0.4694E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1231E+06	89.06%
50		0.1191E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1191E+06	89.16%
	Total Top 50	0.2024E+08	0.2423E+08	0.0000E+00	0.0000E+00	0.7728E+06	38.29	0.4234E+08	0.3887E+06	0.1462E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.6377E+07	0.1009E+09	
	Total All Fac	0.2622E+08	0.2621E+08	0.0000E+00	0.1048E+05	0.1117E+07	129.3	0.4329E+08	0.9034E+06	0.1938E+07	0.0000E+00	0.0000E+00	18.54	0.7400E+07	0.1132E+09	
	% Distribution	23.16%	23.16%	0.00%	0.01%	0.99%	0.00%	38.25%	0.80%	1.71%	0.00%	0.00%	0.00%	6.54%		

Table 4. Total Capital Cost for Equipment Leak Control Case A (Excluding Recyclers)

Total Capital Investment

TOP 50 FACILITIES NATIONWIDE
COST IN $

Fugitives only
Total across subunits

NO	Facility	LTR	INC	PT1	PT2	PT3	PT4	PT5	xDB2	FSP	LDR	XXX	XXX	XXX	Total	Cum%
1		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3581E+08	31.64%
2		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1929E+08	48.68%
3		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7798E+07	55.56%
4		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7698E+07	62.37%
5		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4533E+07	66.37%
6		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2310E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.4330E+07	70.19%
7		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2304E+07	72.23%
8		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2124E+07	74.10%
9		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1885E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.1885E+07	75.77%
10		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1283E+07	76.91%
11		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1270E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.1270E+07	78.03%
12		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1159E+07	79.06%
13		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1068E+07	80.02%
14		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8867E+06	80.81%
15		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7445E+06	81.46%
16		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6744E+06	82.06%
17		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5264E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.5264E+06	82.53%
18		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1815E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.4679E+06	82.94%
19		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4594E+06	83.34%
20		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4316E+06	83.73%
21		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4230E+06	84.10%
22		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4158E+06	84.47%
23		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1296E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.3467E+06	84.77%
24		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3181E+06	85.05%
25		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3143E+06	85.33%
26		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3136E+06	85.61%
27		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2672E+06	85.85%
28		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2644E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.2644E+06	86.08%
29		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2487E+06	86.30%
30		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2331E+06	86.50%
31		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2320E+06	86.71%
32		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1825E+06	86.87%
33		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1793E+06	87.03%
34		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1767E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.1767E+06	87.19%
35		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1758E+06	87.34%
36		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1711E+06	87.49%
37		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1620E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.1620E+06	87.63%
38		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1259E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.1557E+06	87.77%
39		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4438.	0.0000E+00	0.0000E+00	0.0000E+00	0.1490E+06	87.90%
40		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1423E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.1423E+06	88.03%
41		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1383E+06	88.15%
42		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1341E+06	88.27%
43		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1312E+06	88.39%
44		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1309E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.1309E+06	88.50%
45		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1298E+06	88.62%
46		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1254E+06	88.73%
47		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1251E+06	88.84%
48		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1231E+06	88.95%
49		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1231E+06	89.06%
50		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1191E+06	89.16%
Total Top 50		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5120E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.1009E+09	
Total All Fac		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6104E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.1132E+09	
% Distribution		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.39%	0.00%	0.00%	0.00%		

Total Annual Cost

Table 5. Total Annual Cost for Equipment Leak Control Case A (Excluding Recyclers)

TOP 50 FACILITIES NATIONWIDE
COST IN $/yr

Fugitives only
Total across submodels

NO	Facility	S01	S02	S03	S04	T01	T02	T03	T04	879	S80	S81	S83	TAL	Total	Cumul
1		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7446E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7446E+07	25.40%
2		0.0000E+00	0.3476E+07	0.0000E+00	0.0000E+00	0.1324E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.2584E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3867E+07	38.59%
3		0.1821E+05	0.9013E+06	0.0000E+00	0.0000E+00	5741.	0.0000E+00	0.1376E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6339E+05	0.2365E+07	46.72%
4		0.1630E+06	0.0000E+00	0.0000E+00	0.0000E+00	156.0	0.0000E+00	0.0000E+00	0.1382E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1437E+07	0.1633E+07	52.98%
5		0.1565E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1565E+07	58.31%
6		0.9212E+06	0.3245E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2031E+06	0.1448E+07	62.26%
7		0.6334E+06	0.2115E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1344E+06	0.9791E+06	66.60%
8		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3450E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4728E+06	0.5073E+06	68.33%
9		0.2988E+06	0.1104E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7065.	5578.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4250E+06	69.78%
10		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3949E+06	71.13%
11		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3794E+06	72.42%
12		0.2375E+06	0.5326E+05	0.0000E+00	0.0000E+00	1589.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3763E+05	0.3300E+06	73.55%
13		0.1565E+06	0.5674E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9166E+05	0.0000E+00	6044.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3097E+06	74.61%
14		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	519.3	0.0000E+00	0.2320E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6259.	0.2386E+06	75.42%
15		0.1183E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.809	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1923E+06	76.08%
16		0.1157E+06	0.3351E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2587E+05	0.1811E+06	76.69%
17		246.8	0.7023E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1094E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1799E+06	77.31%
18		0.1787E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1787E+06	77.92%
19		0.3431E+05	0.8298E+05	0.0000E+00	0.0000E+00	484.6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5861E+05	0.1764E+06	78.52%
20		0.1625E+06	7436.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5902.	0.1750E+06	79.12%
21		0.1337E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1337E+06	79.57%
22		0.6049E+05	0.2715E+05	0.0000E+00	0.0000E+00	2.260	0.0000E+00	0.3725E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	51.25	0.1330E+06	80.03%
23		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8664	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1107E+06	80.40%
24		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1055E+06	80.76%
25		0.9850E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9850E+05	81.10%
26		0.9837E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9837E+05	81.43%
27		0.5986E+05	0.2087E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1315E+05	0.9388E+05	81.75%
28		123.5	0.5466E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3742E+05	0.9209E+05	82.07%
29		0.4400E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9080E+05	82.38%
30		0.5163E+05	0.1799E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1142E+05	0.8103E+05	82.66%
31		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7385E+05	82.90%
32		0.3818E+05	0.1320E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2073E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7211E+05	83.15%
33		0.4529E+05	0.1568E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1002E+05	0.7099E+05	83.39%
34		28.33	0.5860E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	150.5	0.4603E-02	5002.	0.0000E+00	0.0000E+00	0.0000E+00	110.2	0.6389E+05	83.61%
35		0.5573E+05	17.98	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	178.4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6080E+05	83.82%
36		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5897E+05	84.02%
37		0.3715E+05	0.1275E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8273.	0.5817E+05	84.22%
38		0.5520E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5520E+05	84.41%
39		0.3142E+05	0.1067E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8563.	309.5	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3253.	0.5426E+05	84.59%
40		0.5257E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5257E+05	84.77%
41		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5227E+05	84.95%
42		0.0000E+00	0.2654E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1031E+05	0.1394E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5079E+05	85.12%
43		0.5002E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5002E+05	85.29%
44		0.2900E+05	9745.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7380.	287.7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3028.	0.4904E+05	85.46%
45		0.2989E+05	0.1010E+05	0.0000E+00	0.0000E+00	171.6	0.0000E+00	5040.	0.2559	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1554.	0.4883E+05	85.63%
46		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2765.	0.0000E+00	0.3516E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	9750.	0.4764E+05	85.79%
47		0.4326E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4326E+05	85.94%
48		0.3317E+05	5933.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3843.	0.4295E+05	86.08%
49		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	-0.3098E+05	0.0000E+00	9422.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4040E+05	86.22%
50	--	0.2351E+05	7858.	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	437.9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5318.	0.3718E+05	86.35%
Total Top 50		0.5602E+07	0.5626E+07	0.0000E+00	0.0000E+00	0.1784E+06	7.675	0.9400E+07	0.1569E+06	0.3012E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.2571E+07	0.2531E+08	
Total All Fac		0.7642E+07	0.6260E+07	0.0000E+00	2163.	0.2978E+06	27.00	0.9705E+07	0.3175E+06	0.4354E+06	0.0000E+00	0.0000E+00	3.715	0.2936E+07	0.2932E+08	
% Distribution		26.07%	21.35%	0.00%	0.01%	0.98%	0.00%	33.11%	1.08%	1.49%	0.00%	0.30%	0.00%	10.02%		

Table 5. Total Annual Cost for Equipment Leak Control Case A (Excluding Recyclers)

Total Annual Cost

TOP 50 FACILITIES NATIONWIDE
COST IN $/yr

Fugitives only
Total across subunits

##	Facility	LTR	INC	PT1	PT2	PT3	PT4	PT5	xSO2	FTP	LDR	XXX	XXX	XXX	Total	Cumul
1		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7446E+07	25.40%
2		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3867E+07	38.59%
3		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2385E+07	46.72%
4		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9433E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.1833E+07	52.98%
5		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1562E+07	58.31%
6		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1449E+07	63.26%
7		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9797E+06	66.60%
8		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5073E+06	68.33%
9		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4258E+06	69.78%
10		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3949E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.3949E+06	71.13%
11		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3794E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.3794E+06	72.42%
12		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3300E+06	73.55%
13		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3097E+06	74.61%
14		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.2388E+06	75.42%
15		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7404E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.1923E+06	76.08%
16		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1811E+06	76.69%
17		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1799E+06	77.31%
18		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1787E+06	77.92%
19		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1764E+06	78.52%
20		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1750E+06	79.12%
21		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1337E+06	79.57%
22		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1330E+06	80.03%
23		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1107E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.1107E+06	80.40%
24		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1032E+06	0.0000E+00	0.0000E+00	0.0000E+00	0.1032E+06	80.76%
25		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9858E+05	81.10%
26		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9837E+05	81.43%
27		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9380E+05	81.75%
28		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.9329E+05	82.07%
29		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4680E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.9088E+05	82.38%
30		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.8103E+05	82.66%
31		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7305E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.7305E+05	82.90%
32		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7211E+05	83.15%
33		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.7099E+05	83.39%
34		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.6389E+05	83.61%
35		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4876.	0.0000E+00	0.0000E+00	0.0000E+00	0.6088E+05	83.82%
36		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5897E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.5897E+05	84.02%
37		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5817E+05	84.22%
38		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5529E+05	84.41%
39		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5426E+05	84.59%
40		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5257E+05	84.77%
41		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5227E+05	0.0000E+00	0.0000E+00	0.0000E+00	0.5227E+05	84.95%
42		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5079E+05	85.12%
43		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.5062E+05	85.29%
44		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4944E+05	85.46%
45		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2063.	0.0000E+00	0.0000E+00	0.0000E+00	0.4882E+05	85.63%
46		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4768E+05	85.79%
47		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4326E+05	85.94%
48		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4295E+05	86.08%
49		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.4044E+05	86.22%
50		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.3718E+05	86.35%
	Total Top 50	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1397E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.2531E+08	
	Total All Fac	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.1729E+07	0.0000E+00	0.0000E+00	0.0000E+00	0.2932E+08	
	% Distribution	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.90%	0.00%	0.00%	0.00%		

ATTACHMENT 1

ATTACHMENT 1

PROCEDURE USED BY THE SOURCE ASSESSMENT MODEL (SAM) TO ESTIMATE EMISSIONS FROM EQUIPMENT LEAKS

The procedure used in the SAM to estimate emissions from equipment leaks at TSDF sources is summarized in this attachment in two sections. The first section describes the derivation of model units and emission factors (called "partition fractions" as used in SAM). The second section provides a narrative summary of how the SAM applies these factors to estimate nationwide impacts at all TSDF.

1.0 Model Units and Emission Factors

A large model unit (Model Unit A) was defined based on the model unit described in Reference 1 with 5 pumps, 165 valves, 9 sampling connections, 44 open-ended lines, and 3 pressure-relief devices. The emission factors for each source and the number of components were used to estimate the uncontrolled emissions given in Table 1. Two smaller model units were defined to represent equipment items used in waste management processes that have fewer components than represented by Model unit A. For example, a typical storage tank may have only one pump and is unlikely to have 5 pumps. Model unit B was defined as 60 percent of Model unit A (for example, 3 pumps and 99 valves). Model unit A was defined as 20 percent of Model unit A (for example, 1 pump and 33 valves). Uncontrolled emissions for all three model units are given in Table 2.

There are several different waste management processes at TSDF, and the number of equipment components varies based on the type of process and waste throughput. In Table 3, each waste management process is assigned to one of the three model units based on data from the 1986 Screener Survey[3] and the quantity of waste processed. For each process, an emission factor (partition fraction) is calculated from the model unit emissions divided by the weighted average throughput of waste for the process. The results are summarized in Table 3 for light liquids.

TABLE 1. NUMBER OF COMPONENTS AND EMISSIONS FOR MODEL UNIT A[1,2]

Emission Source	Number of Components[a]	Emission factor (Mg/yr/source)[b]		Uncontrolled emissions (Mg/yr)	
		Light liquid	Heavy liquid	Light liquid	Heavy liquid
Pump seals	5	0.43	0.19	2.15	0.95
Valves	165[c]	0.062	0.002	10.23	0.33
Sampling connections	9	0.13	0.13	1.17	1.17
Open-ended lines	44[d]	0.015	0.015	0.66	0.66
Pressure-relief devices	3	0.91	0.91	2.73	2.73
Total				16.94	5.84

[a] Derived from Reference 1: "RCRA TSDF Air Emissions-Background Technical Memoranda for Proposed Standards." EPA-450/3-86-009. Attachment 7. October 1986.

[b] From Reference 2: "Fugitive Emission Sources of Organic Compounds-Additional Information on Emissions, Emission Reductions, and Costs." EPA-450/3-82-010. April 1982. p. 2-70.

[c] From Reference 1, includes 87 (liquid) + 34 (gas) + 9 (sampling connections) + 35 (open-ended lines).

[d] From Reference 1, includes 35 (open-ended lines) + 9 (sampling connections).

TABLE 2. EMISSION ESTIMATES FOR EACH MODEL UNIT

Model Unit	Uncontrolled emissions (Mg/yr)	
	Light liquid	Heavy liquid
A[a]	16.94	5.84
B[b]	10.16	3.50
C[c]	3.39	1.17

[a] From the total in Table 1.

[b] Model unit B is defined as 60 percent of Model Unit A.

[c] Model unit C is defined as 20 percent of Model Unit A.

TABLE 3. PARTITION FRACTIONS FOR EACH WASTE MANAGEMENT PROCESS FOR LIGHT LIQUIDS

Management Process		Uncontrolled emissions (Mg/yr)[a]	Weighted Average Throughput (Mg/yr)[b]	Partition fraction[c]
Model Unit A:				
Incinerator		16.94	10,035	0.00169
Injection Well		16.94	189,243	0.000090
VO removal devices:				
Steam stripper	3xx[d]	16.94	121,951	0.000139
Distillation	4xx	16.94	17,299	0.000979
Incinerator	5xx	16.94	26,918	0.000629
	1xx	16.94	74,026	0.000229
Model Unit B:				
Treatment tank:				
quiescent		10.16	154,466	0.000066
aerated		10.16	785,632	0.000013
Vo removal devices:				
Air stripper	3xx	10.16	326,395	0.000031
Thin film evaporator	2xx	10.16	17,640	0.000576
Model Unit C:				
Storage tank		3.39	3,350	0.001012
Surface impoundment		3.39	378,622	0.000009
Terminal loading		3.39	4,800	0.000706
Drum loading		3.39	1,200	0.002825

[a] From Table 2.

[b] Quantity of waste processed calculated as a weighted average from the data for all waste processes in SAM.

[c] Uncontrolled emissions divided by throughput.

[d] These are codes for waste forms, where 1xx = inorganic solid, 2xx = aqueous sludge, 3xx = aqueous liquid, 4xx = organic liquid, 5xx = organic sludge, and 6xx = miscellaneous.

Only one set of partition fractions can be read into the SAM for each model unit to estimate emissions. The partition fractions in Table 3 are for light liquids; consequently an adjusting factor was derived to use for heavy liquids. From Table 1, the ratio of emissions of heavy and light liquids is 0.34 (5.84/16.94). Therefore, when SAM determines that a waste stream is a heavy liquid, the partition fractions for light liquids are multiplied by 0.34 to estimate heavy liquid emissions. For a given waste stream, SAM first determines the total organic content. Waste streams with less than 10 percent organics are not affected by the proposed standard for equipment leaks. However, waste streams with over 10 percent total organics will be subject to the equipment leak controls. The model divides those waste streams with over 10 percent organics into light and heavy liquids. Waste streams that contain 20 percent or more by volume of high volatility compounds are classified as light liquids. In SAM, the high volatility compounds are defined as those with a vapor pressure greater than 1.33 kPa or a Henry's law constant greater than 0.1 kPa m^3/g mol. Wastes with over 10 percent total organics but less than 20 percent high volatility organics are classified as heavy liquids. For wastes that are identified as heavy liquids, the model adjusts the emissions by the factor of 0.34 as previously described.

Control techniques and their efficiencies are given in Table 4. The control efficiencies and uncontrolled emission estimates are used in Table 5 to estimate controlled emissions for two control options. Option 1 includes monthly leak detection and repair for pumps and valves and equipment controls for the other sources. Option 2 substitutes dual mechanical seals for leak detection and repair for pumps. The overall emission reductions are given in Table 5 for Model unit A and were used in the SAM to estimate the overall controlled emissions for the two options.

2.0 SOURCE ASSESSMENT MODEL (SAM)

Details on the structure of SAM are given in Reference 6 and are summarized in this section. The SAM is a computer model used to estimate total nationwide impacts from emissions at TSDF. The model contains information on over 2,300 TSDF nationwide and the various waste management processes used at each facility. In addition, the model contains waste concentration data for the various types of hazardous wastes processed at these facilities. The waste

TABLE 4. CONTROLS AND THEIR EFFICIENCES FOR EQUIPMENT LEAKS[4,5]

Source	Control	Control efficiency (percent) Light liquid	Control efficiency (percent) Heavy liquid
Pump seals	Leak detection and repair[a]	61	0
	Dual mechanical seals[b]	100	100
Valves	Leak detection and repair	59	0
Sampling connections	Closed-purge sampling	100	100
Open-ended lines	Caps	100	100
Pressure-relief devices	Rupture disks	100	100

[a] Includes leak detection and repair with monthly inspections.

[b] Dual mechanical seals with barrier fluid and degassing reservoir vent.

TABLE 5. ESTIMATES OF CONTROLLED EMISSIONS FOR MODEL UNIT A[a]

Source	Light liquid emissions (Mg/yr) Option 1[b]	Light liquid emissions (Mg/yr) Option 2[c]	Heavy liquid emissions (Mg/yr) Option 1	Heavy liquid emissions (Mg/yr) Option 2
Pump seals	0.839	0	0.95	0
Valves	4.19	4.19	0.33	0.33
Sampling connections	0	0	0	0
Open-ended lines	0	0	0	0
Pressure-relief devices	0	0	0	0
Total	5.03	4.19	1.28	0.33
Overall percent reduction	70.3	75.3	78.1	94.3

[a] Estimated from the uncontrolled emissions in Table 1 and the control efficiencies in Table 4.

[b] Option 1 includes monthly leak detection and repair for pumps and valves, closed-purge sampling, caps for open-ended lines, and rupture disks for pressure-relief devices.

[c] Option 2 includes dual mechanical seals for pumps and controls for other sources as listed for Option 1.

concentration data are expressed in terms of surrogate compounds classified in terms of volatility (high, medium, and low). For each facility, the SAM models emissions from various waste management processes as the waste stream travels through different units at the facility. The model also adjusts (reduces) the organic concentration of the waste stream that enters a given process to account for losses of organics by emissions from a previous processing step.

For equipment leaks, the model first determines the concentration of total organics in a given waste stream at a particular facility. If the concentration is greater than 10 percent total organics, the waste stream is identified as a candidate for control of equipment leaks. The waste streams with over 10 percent total organics are then identified as either light liquids (20 percent or more high volatility compounds) or heavy liquids (less than 20 percent high volatility compounds). The model then determines which waste management processes are used for this waste stream at the given facility from the model's industry profile data base. The industry profile was developed from TSDF survey data and contains a record of how each waste stream at each facility is processed. For each waste stream and facility, data are provided for storage (in containers, tanks, waste piles, and surface impoundments) treatment (in tanks, impoundments, incinerators, and other) and disposal (injection well, landfill, land application, and impoundment). If the waste stream is processed in different waste management units, the model assigns a logical processing sequence, such as storage followed by treatment and disposal. Terminal loading is assigned to those facilities that are most likely to ship waste offsite. The facilities with terminal loading are identified as those that do not have a disposal process listed for the waste stream and the last process used for the waste stream is not incineration or placement in a waste pile.

The partition fraction for the waste management process is chosen from Table 3, and emissions are estimated from the partition fraction times the quantity of waste processed (from the 1986 National Screener Survey of TSDR, which is in the SAM database for the given facility) times the adjusting factor for heavy liquids, if appropriate. This calculation is performed for each process at each facility, and emissions from each facility are summed to estimate total nationwide emissions. Controlled emissions are estimated by applying the overall efficiencies given in Table 5.

3.0 REFERENCES

1. U.S. EPA. RCRA TSDF Air Emissions-Background Technical Memoranda for Proposed Standards. EPA-450/3-86-009. Attachment 7. October 1986.

2. U.S. EPA. Fugitive Emission Sources of Organic Compounds-Additional Information on Emissions, Emission Reductions, and Costs. EPA-450/3-82-010. April 1982. p. 2-70.

3. Office of Solid Waste. National Screening Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities. U.S. EPA. Washington, DC. June 1987.

4. U.S. EPA. RCRA TSDF Air Emissions-Background Technical Memoranda for Proposed Standards. EPA-450/3-86-009. Attachment 7. October 1986.

5. U.S. EPA. Fugitive Emission Sources of Organic Compounds-Additional Information on Emissions, Emission Reductions, and Costs. EPA-450/3-82-010. April 1982, p. 4-43, 4-55, 4-56.

6. U.S. EPA. Hazardous Waste TSDF - Background Information for proposed RCRA Air Emission Standards (Draft). November 1988. Appendix D.

ATTACHMENT 2

ATTACHMENT 2

SUMMARY OF PROCEDURE DEVELOPED FOR THE SOURCE ASSESSMENT MODEL (SAM) TO ESTIMATE CONTROL COSTS FOR EQUIPMENT LEAKS

The steps used to develop cost functions for control of equipment leaks are described below. The descriptions are keyed to the tables, which provide the cost details and the results. Two control options were investigated. The first one is described in Steps 1 through 6 and includes leak detection and repair for pumps and valves, closed-purge sampling for sampling connections, caps for open-ended lines, and rupture disks for pressure-relief valves. The second control option (described in Steps 7 through 10) is similar except that dual mechanical seals with a barrier fluid are applied to pumps.

1. The control costs were taken from Reference 1 and are summarized in Table 1. The controls include leak detection and repair for pump seals and valves, closed-purge sampling, rupture disks for pressure relief devices, and caps for open-ended lines. These costs were updated to 1986 dollars and apply to equipment in light-liquid service. The annual operating cost was calculated from the annualized cost minus the capital recovery factor (.2296) times the capital cost. (Capital recovery costs will be added back in by SAM to estimate total annualized costs.)

2. A large model unit was defined for TSDR based on the model unit presented in Reference 1. The number of components for TSDF Model Unit A is given in Table 2. The costs were scaled from Table 1 based on the number of components.

3. For equipment in heavy liquid service, the leak detection and repair program is not applicable. However, the equipment controls (closed purge sampling, rupture disk, caps) are applicable. The control costs for heavy liquids are summarized in Table 3.

4. Three model units were defined for TSDF sources. Model Unit A is the large unit with the number of components defined in Table 2. Model Unit B is medium size and is 60 percent (in components and cost) of Model Unit A. Model Unit C is a small unit and is defined as 20 percent of Model Unit A. The control costs for the three model units are summarized in Table 4.

TABLE 1. COST DATA FOR CONTROL OF EQUIPMENT LEAKS - LIGHT LIQUID SERVICE[a,b]

Source	Number[b]	TCI[b] (1985$)	TCI[c] (1986$)	Annual cost[b] (1985$/yr)	AOC[d] (1985$/yr)	AOC[c] (1986 $/yr)
Pump seals	5	292	292	1,787	1,720	1,722
Valves	121	336	336	2,378	2,301	2,304
Sampling connections	9	6,146	6,154	1,530	119	119
Open-ended lines	35	2,338	2,341	560	23.2	23.2
Pressure-relief valves	3	11,541	11,557	3,280	630	631
Monitoring device	1	6,309	6,318	2,366	917	918

TCI = Total capital investment.

AOC = Annual operating cost.

[a] Controls include leak detection and repair for pumps and valves; equipment controls for other sources.

[b] Taken from Reference 1: "RCRA TSDF Air Emissions-Background Technical Memoranda for Proposed Standards." EPA-450/3-86-009. October 1986. Attachment 7.

[c] Based on a cost index of 1.0013 for 4th quarter 1985 to January 1986.

[d] AOC = Annual Cost - (.2296) (TCI) where .2296 is the capital recovery factor based on a 6-yr life and 10 percent interest.

TABLE 2. COST DATA FOR TSDF MODEL UNIT A - EQUIPMENT LEAK CONTROLS FOR LIGHT LIQUID SERVICE[a]

Source	Number	TCI (1986$)	AOC (1985$/yr)	TAC[b] (1986$/yr)
Pump seals[c]	5	292	1,722	1,789
Valves	165[d]	458[e]	3,142[e]	3,247
Sampling connections	9	6,154	119	1,532
Open-ended lines	44[f]	2,943[g]	29[g]	705
Pressure-relief valves	3	11,557	631	3,284
Total		21,404	5,643	10,557
Monitoring device	1	6,318	918	2,369

TCI = Total capital investment.

AOC = Annual operating cost.

TAC = Total annualized cost.

[a] Based on leak detection and repair for pump seals and valves, equipment controls for the other sources. For equipment in light liquid service.

[b] Based on an equipment life of 6 years and 10 percent interest with a capital recovery factor of 0.2296.

[c] From Table 1 (1986 dollars).

[d] From Reference 1, includes 87 (liquid) + 34 (gas) + 9 (sampling connections) + 35 (open-ended lines).

[e] Scaled up from Table 1 by 165/121.

[f] From Reference 1, includes 35 (open-ended lines) + 9 (sampling connections).

[g] Scaled up from Table 1 by 44/35.

TABLE 3. COST DATA FOR TSDF MODEL UNIT A - EQUIPMENT LEAK CONTROLS FOR HEAVY LIQUID SERVICE[a]

Source	Number[b]	TCI (1986$)[b]	AOC (1986$/yr)[b]	TAC (1986$/yr)[b]
Sampling connections	9	6,154	119	1,532
Open-ended lines	44	2,943	29	705
Pressure-relief valves	3	11,557	631	3,284
Total		20,654	779	5,521

TCI = Total Capital investment.

AOC = Annual operating cost.

TAC = Total annualized cost.

[a] Controls include equipment items for the sources. Leak detection and repair program is not applied to heavy liquids.

[b] From Table 2.

TABLE 4. SUMMARY OF EQUIPMENT LEAK CONTROL COSTS FOR TSDF MODEL UNITS[a]

Model unit	TCI (1986$) Monitor	TCI (1986$) Equipment	AOC (1986$/yr) Monitor	AOC (1986$/yr) Equipment	TAC (1986$/yr) Monitor	TAC (1986$/yr) Equipment
Light liquid:						
A[b]	6,318	21,404	918	5,643	2,369	10,557
B[c]	6,318	12,842	918	3,386	2,369	6,334
C[d]	6,318	4,281	918	1,129	2,369	2,111
Heavy liquid:						
A[e]	--	20,654	--	779	--	5,521
B[c]	--	12,392	--	467	--	3,313
C[d]	--	4,131	--	156	--	1,104

TCI = Total Capital investment.

AOC = Annual operating cost.

TAC = Total annualized cost.

[a] Includes leak detection and repair for pump seals and valves in light-liquid service. Equipment controls for other sources.

[b] From Table 2.

[c] Model Unit B is 60 percent of Model Unit A.

[d] Model Unit C is 20 percent of Model Unit A.

[e] From Table 3.

5. The model units are assigned to TSDF processes based on the size and complexity of the process and auxiliary equipment. For example, numerous pieces of equipment are associated with an incinerator; therefore, Model Unit A is used for this process. Model Unit C is assigned to a single storage tank because the associated equipment count would be small. The model unit assignments by process are given in Table 5. Also given in Table 5 is the average annual throughput for the process. The model unit cost divided by the throughput yields the slope (B,B') of the cost function.

Each facility must purchase a monitoring device, and the other costs associated with controlling equipment leaks are assumed to be a function of the process throughput. The cost functions from Table 5 are used in SAM to estimate costs, where:

Total capital investment = 6,318 + B (Quantity, Mg/yr)
for a facility

Annual operating cost = 918 + B' (Quantity, Mg/yr).
for a facility

The slope (B,B') times the quantity of waste processed yields an estimate of costs for each source, and the cost of a monitoring device is added only once per facility, independent of throughput. Total nationwide costs are estimated by summing the costs across each facility.

6. The cost functions in Table 5 are for equipment in light liquid service. Because only one set of fugitive cost functions can be read into SAM for each model unit, an adjusting factor was derived for heavy liquids. From Table 4, the ratio of capital control costs for heavy/light liquids for Model Unit A is 20,654/21,584 = 0.957. The cost function for light liquids was multiplied by this factor in SAM to estimate the control costs for heavy liquids. Similarly for annual operating costs, a factor of 779/6871 = 0.113 (from Table 4) was used for heavy liquids.

7. The second control option includes dual mechanical seals for pumps instead of leak detection and repair. The control for other sources remain the same as those in the first option. The costs for Model Unit A are summarized in Table 6 for control of light liquids.

8. Table 7 summarizes the costs for control of heavy liquids emissions from pumps, sampling connections, open-ended lines, and pressure-relief valves for Model Unit A.

TABLE 5. COST FUNCTIONS FOR EQUIPMENT LEAK CONTROL COSTS - LIGHT LIQUIDS[a]

Process	Model unit[b]	Throughput[c] (Mg/yr)	B for TCI[d]	B^1 for AOC[e]
Incinerator	A	10,000	2.14	.564
Injection well	A	189,000	.113	.0299
Quiescent treatment tank	B	154,000	.0834	.022
Aerated treatment tank	B	786,000	.0163	.0043
Storge tank	C	3,350	1.28	.337
Storage impoundment	C	5,830	.734	.194
Treatment impoundment	C	379,000	.0113	.00298
Disposal impoundment	C	31,500	.136	.0358
Drum loading	C	1,200	3.57	.941
Terminal loading	C	4,800	.892	.235

TCI = Total Capital investment.
AOC = Annual operating cost.

[a] The table shows how the cost function is calculated for use in SAM. The equipment cost for the given model unit from Table 4 is divided by the weighted average annual throughput to calculate B and B^1.

[b] Model unit assigned to given TSDF process. Model unit A is large (equipment count in Table 2), B is medium (60 percent of A), and C is small (20 percent of A).

[c] Weighted average annual throughput for the TSDF process from SAM.

[d] Cost function for TCI = 6,318 + $B \cdot Q$ (Mg/yr) where 6,318 is the cost of a monitoring device, B is given in the table, and Q is the throughput of a specific facility's process in Mg/yr.

[e] Cost function for AOC = 918 + $B^1 \cdot Q$ (Mg/yr) where 918 is the annual operating cost for the monitor, B^1 is given in the table, and Q is the throughput of a specific facility's process in Mg/yr.

TABLE 6. COST DATA FOR TSDF MODEL UNIT A - EQUIPMENT LEAK CONTROLS FOR LIGHT LIQUID SERVICE WITH DUAL MECHANICAL SEALS FOR PUMPS[a]

Source	Number	TCI (1986$)	AOC (1986$/yr)	TAC (1986$/yr)
Pump seals	5	48,250[b]	3,820[b]	14,900
Valves[c]	165	458	3,142	3,247
Sampling connections[c]	9	6,154	119	1,532
Open-ended lines[c]	44	2,943	29	705
Pressure- relief valves	3	11,557	631	3,284
	Total	69,362	7,741	23,668
Monitoring device[c]	1	6,318	918	2,369

TCI = Total Capital investment.

AOC = Annual operating cost.

TAC = Total annualized cost.

[a] Controls include dual mechanism seals with a barrier fluid and degassing vents for pumps, leak detection, and repair for valves, closed-purge sampling, rupture disks, and caps for open-ended lines.

[b] From Appendix F in Reference 2: "Benzene Emissions from Coke By-product Recovery Plants - BID." EPA-450/3-83-016a. May 1984. Scaled from 1979 dollars by f = 1.487. Capital recovery factor = 0.2296 (6 yr. life at 10 percent interest).

[c] These costs were taken from Table 2.

TABLE 7. COST DATA FOR TSDF MODEL UNIT A - WITH DUAL MECHANICAL SEALS FOR PUMPS - HEAVY LIQUID SERVICE[a]

Source	Number	TCI (1986$)	AOC (1986$/yr)	TAC (1986$/yr)
Pumps[b]	5	48,250	3,820	14,900
Sampling connections[c]	9	6,154	119	1,532
Open-ended lines[c]	44	2,943	29	705
Pressure-relief valves[c]	3	11,557	631	3,284
	Total	68,904	4,599	20,421

TCI = Total Capital investment.

AOC = Annual operating cost.

TAC = Total annualized cost.

[a] Controls include equipment items for the sources.

[b] From Table 6.

[c] From Table 3.

9. The costs for the large model unit in Table 6 and 7 were used to estimate the cost for the two smaller units (at 60 and 20 percent of Model Unit A). The costs for all three model units are given in Table 8 for the application of dual mechanical seals to pumps.

10. The cost functions for controls that include dual mechanical seals for pumps are given in Table 9. These cost functions are used in SAM as described in Step 5 to estimate the control costs for this option.

REFERENCES

1. USEPA. RCRA TSDF Air Standards - Background Technical Memoranda For Proposed Standards. EPA-450/3-86-009. October 1986.

2. USEPA. Benzene Emissions from Coke By-product Recovery Plants-Background Information Document. EPA-450/3-83-016a. May 1984. p. F-5.

TABLE 8. SUMMARY OF EQUIPMENT LEAK CONTROL COSTS WITH DUAL MECHANICAL SEALS FOR PUMPS[a]

Model unit	TCI (1986$)		AOC (1986$/yr)		TAC (1986$/yr)	
	Monitor	Equipment	Monitor	Equipment	Monitor	Equipment
Light liquid:						
A[b]	6,318	69,362	918	7,741	2,369	23,668
B[c]	6,318	41,617	918	4,645	2,369	14,200
C[d]	6,318	13,872	918	1,548	2,369	4,734
Heavy liquid:						
A[e]	--	68,904	--	4,599	--	20,421
B[c]	--	41,342	--	2,759	--	12,253
C[d]	--	13,781	--	920	--	4,084

TCI = Total Capital investment.

AOC = Annual operating cost.

TAC = Total annualized cost.

[a] Included dual mechanism seals for pumps, leak detection and repair for valves, and equipment controls for the other sources.

[b] From Table 6.

[c] Model Unit B is 60 percent of Model Unit A.

[d] Model Unit C is 20 percent of Model Unit A.

[e] From Table 7.

TABLE 9. COST FUNCTIONS FOR EQUIPMENT LEAK CONTROL COSTS (DUAL MECHANICAL SEALS FOR PUMPS) - LIGHT LIQUIDS[a]

Process	Model unit[b]	Throughput[c] (Mg/yr)	B for TCI[d]	B^1 for AOC[e]
Incinerator	A	10,000	6.94	.774
Injection well	A	189,000	.367	.041
Quiescent treatment tank	B	154,000	.269	.030
Aerated treatment tank	B	786,000	.053	.0059
Storge tank	C	3,350	4.14	.462
Storage impoundment	C	5,830	2.38	.266
Treatment impoundment	C	379,000	.0366	.0041
Disposal impoundment	C	31,500	.440	.049
Drum loading	C	1,200	11.6	1.29
Terminal loading	C	4,800	2.89	.323

TCI = Total Capital investment.
AOC = Annual operating cost.

[a] The table shows how the cost function is calculated for use in SAM. The equipment cost for the given model unit from Table 8 is divided by the weighted average annual throughput to calculate B and B^1.

[b] Model unit assigned to given TSDF process. Model unit A is large (equipment count in Table 2), B is medium (60 percent of A), and C is small (20 percent of A).

[c] Weighted average annual throughput for the TSDF process from SAM.

[d] Cost function for TCI = 6,318 + B•Q (Mg/yr) where 6,318 is the cost of a monitoring device, B is given in the table, and Q is the throughput of a specific facility's process in Mg/yr.

[e] Cost function for AOC = 918 + $B^1 \cdot Q$ (Mg/yr) where 918 is the annual operating cost for the monitor, B^1 is given in the table, and Q is the throughput of a specific facility's process in Mg/yr.

RESEARCH TRIANGLE INSTITUTE

Center for Environmental Systems

DRAFT

September 30, 1988

MEMORANDUM

TO: Rick Colyer, EPA/SDB, and Robert Lucas, EPA/CPB

FROM: Steve York and Robert Zerbonia, RTI

SUBJECT: Estimation of Nationwide Uncontrolled Emissions from Solvent Recycling Facilities for the Accelerated Rule Post Proposal Analysis

The purpose of this memo is to present estimates of nationwide uncontrolled organic emissions from solvent recycling facilities (WSTF and facilities that reuse solvent as fuel but do not have on-site solvent recovery operations). The estimates are based on facility and waste throughput information summarized in the industry profile[1] and model unit parameters presented in the RTI memorandum recommending WSTF/TSDF model unit parameters.[2]

Table 1 presents lower bound and upper bound estimates of nationwide annual uncontrolled process vent emissions from WSTF. The nationwide total of 448 facilities represents the number of facilities reporting solvent recovery operations, such as batch distillation or fractionation, involving some form of waste at the facility in the 1986 National Screening Survey of Hazardous Waste Treatment, Storage, Disposal and Recycling Facilities. Though this may be an overestimate of the number of WSTF (435 of these facilities did report recycling solvents or halogenated organics in their solvent recovery operations, 13 did not) it is the best available estimate of the number of facilities with process vents subject to the proposed rule. Of the 448 facilities reporting solvent recovery operations, 365 reported the total quantity of waste (all types, including waste categories other than solvents) recycled in 1985.

This information was used to produce the frequency distribution of waste throughput presented in Table 1.0 of Reference 1. The midpoint or average of each throughput range is used as the 1985 throughput in Table 1. The estimated distribution of number of facilities by 1985 throughput in Table 1 was generated using the frequency distribution (proportion in internal, %) from Table 1.0.

Lower bound and upper bound uncontrolled process vent emissions were estimated by applying the minimum and maximum VOC emission factors (gVO/kgTO) for the small, medium and large draft model units presented in Table 1 of Reference 2, assuming 7 lb/gal of throughput. Small model unit emission factors were applied to facilities with throughputs less than 50,000 gallons per year; medium model unit emission factors in the throughput range from 50,000 to less than 1,000,000 gallons per year; and large model unit emission factors in the throughput range greater than or equal to 1,000,000 gallons per year.

Post Office Box 12194 Research Triangle Park, North Carolina 27709 Telephone: 919 541-6000

Table 2 presents estimates of nationwide annual uncontrolled equipment leak emissions from solvent recycling facilities. The model units are presented in Table 2 of Reference 2 and are similar to those used for the equipment leak analysis in the Source Assessment Model and those used for the benzene fugitive emission model units. SOCMI VOC emissions factors were used to estimate organic emissions for each source; operating hours were assumed to be 8,760 hr/yr. The total numbers of small, medium and large facilities were derived from the industry profile using the throughput ranges described in the previous paragraph. Table 3 presents the estimates of nationwide annual uncontrolled equipment leak emissions from TSDF reusing waste solvent as fuel with no solvent recovery operations on site. These fuel reuse operations are characterized as fuel blending units. It should be noted that the Source Assessment Model (SAM) will be used to estimate nationwide annual uncontrolled and controlled equipment leak emissions associated with other TSDF management processes handling hazardous wastes with an organic content of greater than 10% total organics. These TSDF management processes would include drum handling, storage tasks, treatment tanks, incinerators, impoundments, stabilization processes, and so on.

Table 4 summarizes the lower bound and upper bound estimates of nationwide annual uncontrolled organic emissions from WSTF. The estimated range of total nationwide organic emissions compares quite closely with the range estimated for the proposed rule (a range of 8,130 to 15,930 Mg/yr vs. a range of 2,550 to 14,740 Mg/yr estimated for the proposed rule). The post proposal estimated number of WSTF has increased from 95 to 448. In addition, 108 solvent recycling facilities have been identified that reuse solvent as fuel but do not have on-site solvent recovery operations. However, the impact on the uncontrolled emission estimate of increasing the number of facilities has been offset by the estimated distribution of small, medium and large model units and the revised emission factors.

The most noticeable difference between the post proposal uncontrolled emission estimate and the proposal estimate is in the increased relative contribution of equipment leaks emissions to total nationwide emissions from waste solvent recycling units. At proposal, equipment leaks accounted for between 9 and 51 percent of total uncontrolled emissions from WSTF. In the post proposal analysis, equipment leaks account for between 46 and 95 percent of total uncontrolled emissions from WSTF. Including the facilities reusing solvent as fuel, equipment leaks account for between 49 and 96 percent of uncontrolled emissions from solvent recycling units.

References

1. Zerbonia, Robert A. (RTI). Industry Profile-Proposed Air Emissions Standards for Volatile Organics Control from Hazardous Waste Treatment, Storage, and Disposal Facilities. Prepared for U.S. Environmental Protection Agency. Research Triangle Park, NC. August 13, 1987. 33p.

2. Memorandum and attachments from Zerbonia, Robert and York, Steve, RTI, to Colyer, Rick, EPA/SDB. September 28, 1988. 24p. Model unit parameters (Accelerated Rule) post proposal analysis.

SY/RZ/ddf

TABLE 1. LOWER BOUND AND UPPER BOUND ESTIMATES OF NATIONWIDE ANNUAL UNCONTROLLED PROCESS VENT ORGANIC EMISSIONS FROM WSTF

1985 Throughput, 1,000 gallons	Number of Facilities	Annual Uncontrolled Process Vent Emissions, Mg Organics	
		Lower Bound	Upper Bound
.25	16	0.03	0.38
.75	22	0.13	1.6
3.0	50	1.2	14
7.5	42	2.5	30
30	78	19	220
75	58	14	410
300	69	66	2,000
750	40	95	2,900
1,500	23	11	270
3,500	28	31	780
7,500	12	29	720
10,000	10	32	800
Nationwide Total	448	300	8,100

TABLE 2. ESTIMATES OF NATIONWIDE ANNUAL UNCONTROLLED EQUIPMENT LEAK EMISSIONS FROM SOLVENT RECYCLING FACILITIES[a]

Emission Source	Number of Sources			Annual Emissions, Mg Organics/Model Unit		
	Large Model Unit # 1	Medium Model Unit # 2	Small Model Unit # 3	Large # 1	Medium # 2	Small # 3
Pump Seals						
Light Liquid	15	5	3	6.6	2.2	1.3
Compressors	0	0	0	-	-	-
Flanges	0	0	0	-	-	-
Valves						
Gas	106	34	20	5	1.7	1.0
Liquid	264	87	52	16.4	5.4	3.2
Pressure Relief Devices						
Gas	9	3	2	8.1	2.7	1.8
Liquid	0	0	0			
Sampling Connections	26	9	5	3.5	1.2	0.7
Open Ended Lines	105	35	21	1.5	0.5	0.3
Model Unit Totals	519	173	103	41.1	13.7	8.3
Number of WSTF	73	167	208			
Nationwide Total, Emissions Mg organics/yr				3000.3	2287.9	1726.4
Grand Total, Mg/yr					7014.6 (~7010 Mg/yr)	

TABLE 3. ESTIMATES OF NATIONWIDE ANNUAL UNCONTROLLED EQUIPMENT LEAK EMISSION FROM TSDF FUEL BLENDING UNITS.

Emission Source	Model Unit Characteristics (Reuse as Fuel) Model Unit #4	Model Unit #5	Model Unit #6
Pumps	5	3	1
Valves	121	72	24
Sampling connections	9	5	2
Open-ended lines	35	21	7
Pressure relief valves	3	2	1
Total number of facilities	26	40	42
Model Unit Annual Emissions (Mg/yr)	13.7	8.3	3.1
Nationwide Total Emissions (Mg/yr)	356.2	332	130.2
Grand Total (Mg/yr)		818.4 (~820 Mg/yr)	

TABLE 4. LOWER BOUND AND UPPER BOUND ESTIMATES OF NATIONWIDE ANNUAL UNCONTROLLED ORGANIC EMISSIONS FROM SOLVENT RECYCLING FACILITIES

	Nationwide Uncontrolled Organic Emissions, Mg VO/yr		
	Process Vent	Equipment Leak	Total
Lower Bound Estimate	300	7,830	8,130
Upper Bound Estimate	8,100	7,830	15,930

APPENDIX D

SOURCE ASSESSMENT MODEL

APPENDIX D

SOURCE ASSESSMENT MODEL

D.1 DESCRIPTION OF MODEL

D.1.1 Overview

The standard-setting process for hazardous waste transfer, storage, and disposal facilities (TSDF) involves identifying the sources of air pollutants within the industry and evaluating the options available for controlling them. The control options are based on different combinations of technologies and degrees of control efficiency, and they are typically investigated in terms of their nationwide environmental, health, economic, and energy impacts. Therefore, information and data concerning TSDF processes, emissions, emission controls, and health risks associated with TSDF pollutant exposure are being made available for input to the review and decisionmaking process.

The Source Assessment Model (SAM) is a tool that was developed to generate the data sets necessary for comparison of the various TSDF control options. The SAM is a complex computer program that uses a wide variety of information and data concerning the TSDF industry to calculate nationwide impacts (environmental, cost, health, etc.) through summation of approximate individual facility results. It should be pointed out that the primary objective and intended use of the SAM is to provide reasonable estimates of TSDF impacts on a national level. Because of the complexity of the hazardous waste management industry and the current lack of detailed information for individual TSDF, the SAM was developed to utilize national average data where site-specific data are not available. As a result, the SAM impact estimates are not considered accurate for an individual facility. However, on a nationwide basis, the SAM impact estimates are a reasonable approximation and provide the best available basis for analysis of options for controlling TSDF air emissions.

D.1.2 Facility Processor

Information processed by the SAM includes results from recent TSDF industry surveys, characterizations of the TSDF processes and wastes, as well as engineering simulations of the relationships among: (1) waste management unit type, waste, and emission potential (emission models); (2) pollution control technology, equipment efficiencies, and associated capital and operating costs; and (3) exposure and health impacts for TSDF pollutants (carcinogen potency factors).

Inputs to the SAM calculations have been assembled into specific data files. Figure D-1 outlines the functions and processing sequence of the SAM and shows the data files used as input to the model and the output files generated by the SAM.

The facility processor is a segment of the program that accesses the SAM input files and retrieves the information/data required for a particular determination or calculation. The facility processor contains, in a series of subroutines, all the program logic and decision criteria that are involved in identifying TSDF facilities, their waste management processes, waste compositions, and volumes; assigning chemical properties to waste constituents and control devices to process units; and calculating uncontrolled emissions, emissions reductions, control costs, and health impacts. The facility processor also performs all the required calculations associated with estimating emissions, control costs, and incidence. Other functions of the SAM facility processor include performing a waste stream mass balance calculation for each process unit to account for organics lost to the atmosphere, removed by a control device, or biodegraded; testing each waste stream for volatile organic (VO) content and vapor pressure based on models of the laboratory tests; determining total organics by volatility class for each waste stream; and checking for waste form, waste code, and management process incompatability.

D.1.3 Industry Profile

Waste management processes, waste types, and waste volumes for each facility are included in the SAM Industry Profile. This file contains each TSDF name, location, primary standard industrial classification (SIC) code, and the waste volume and management process reported for that particular facility for each waste type (Resource Conservation and Recovery

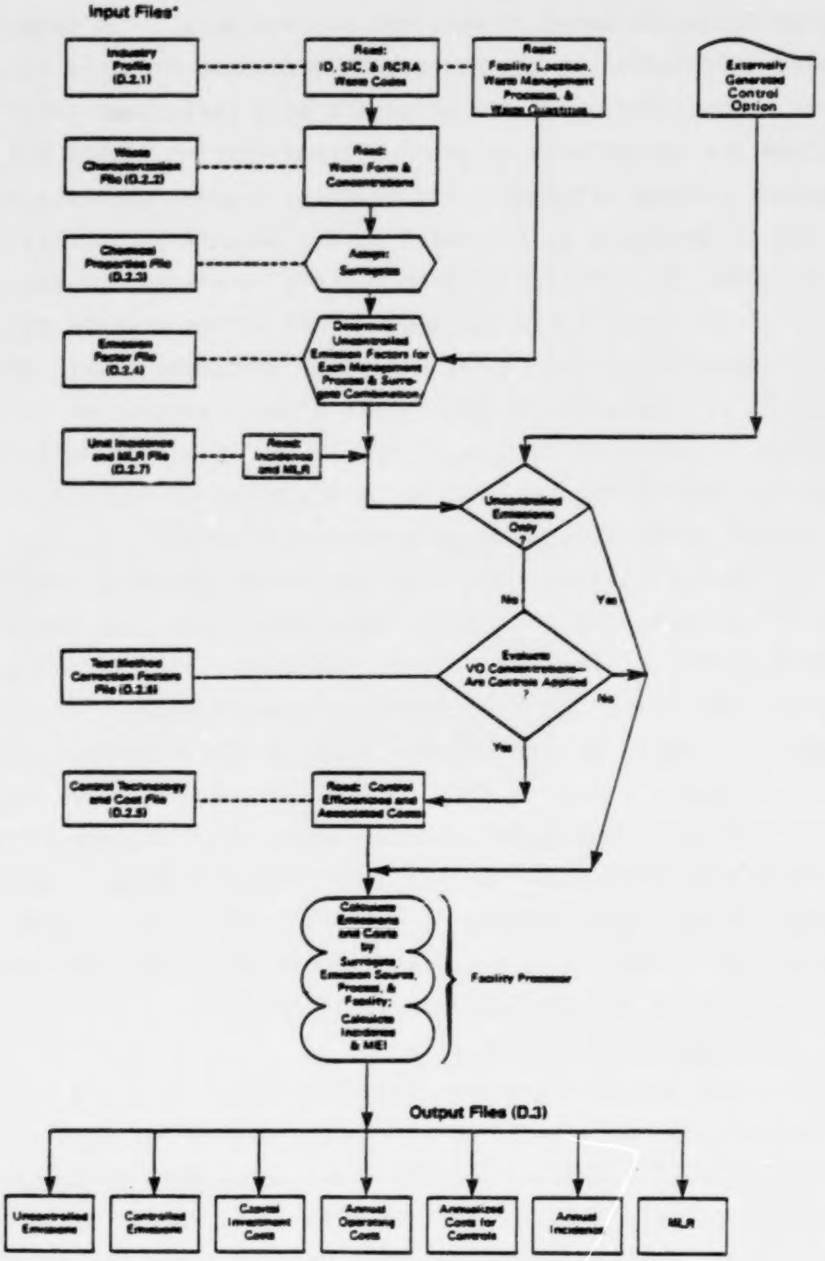
Input Files*
Industry Profile (D.2.1)
Read: ID, SIC, & RCRA Waste Codes
Read: Facility Location, Waste Management Processes, & Waste Quantities
Externally Generated Control Option
Waste Characterization File (D.2.2)
Read: Waste Form & Concentrations
Chemical Properties File (D.2.3)
Assign: Surrogates
Emission Factor File (D.2.4)
Determine: Uncontrolled Emission Factors for Each Management Process & Surrogate Combination
Unit Incidence and MLR File (D.2.7)
Read: Incidence and MLR
Uncontrolled Emissions Only ?
No
Yes
Test Method Correction Factors File (D.2.6)
Evaluate VO Concentrations— Are Controls Applied ?
No
Yes
Control Technology and Cost File (D.2.5)
Read: Control Efficiencies and Associated Costs
Calculate Emissions and Costs by Surrogate, Emission Source, Process, & Facility; Calculate Incidence & MEI
Facility Processor
Output Files (D.3)
Uncontrolled Emissions
Controlled Emissions
Capital Investment Costs
Annual Operating Costs
Annualized Costs for Controls
Annual Incidence
MLR

Figure D-1. Source Assessment Model flow diagram.

*The parentheses refer to the appropriate sections of Appendix D that describe in detail the SAM input files.

Act [RCRA] waste code). Where the level of detail contained in the SAM Industry Profile is not adequate for facility-specific determinations, the SAM uses estimates based on national average data. The Industry Profile contains information on the management processes that are in operation and the waste quantities that are processed at a particular facility. What is not known are the details on process subcategories within the general management process category. For example, a given quantity of waste is reported as processed by treatment tanks; because no further information is available, the SAM uses data on national averages for the distribution and use of treatment tanks to identify and assign process subcategories (i.e., covered quiescent tanks, uncovered quiescent tanks, and uncovered aerated tanks) and to distribute waste quantities treated within these subcategories for each particular facility. This nationwide averaging results in impacts that may not be accurate for an individual facility but when summed yields reasonable nationwide estimates.

The SAM facility-specific information was obtained from three principal sources. Waste quantity data were taken from the 1986 National Screening Survey of Hazardous Waste, Treatment, Storage, Disposal, and Recycling Facilities (1986 Screener).[1,2] Waste management scenarios (or processing schemes) in the SAM were based on the Hazardous Waste Data Management System's (HWDMS) RCRA Part A applications,[3] the National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities Regulated Under RCRA in 1981 (Westat Survey),[4] and the 1986 Screener. Waste types managed in each facility were obtained from all three sources. For a more detailed discussion of the TSDF Industry Profile, refer to Section D.2.1 of this appendix.

D.1.4 Waste Characterization File

The Waste Characterization Data Base (WCDB) is a SAM file that contains waste data representative of typical wastes for each industrial classification (SIC code). The SAM links waste data to specific facilities by the primary SIC code and the RCRA waste codes (waste type) identified for that facility in the Industry Profile. For those SIC codes for which no waste data were available, waste compositions were estimated using the available data bases. Waste data reported for facilities with similar processes were reviewed, and waste stream characteristics typical of the particular process were identified. Thus, each SIC code is assigned applicable RCRA waste codes.

A RCRA waste may be generated in one of several physical/chemical forms (e.g., an organic liquid or an aqueous sludge); therefore, the RCRA waste codes were categorized in the waste characterization file according to general physical and chemical form. Each physical/chemical form of a waste code is assumed to contain the composition of chemical constituents at the respective concentrations for the RCRA waste code. The SAM uses this aspect of the WCDB to distribute waste forms within a RCRA waste code and to provide a representative chemical composition for each form of waste. The quantitative distribution of physical/chemical forms within a waste code was developed from the quantities reported in the Westat Survey data base by the physical and chemical form of the waste code.

Waste composition is used to estimate emissions on the basis of concentration and volatility of the chemicals present in the waste. Once waste form distributions are established, the SAM facility processor searches for chemical compositions to assess the volatility and emission potential of each waste code/form combination for use in emission calculations. Waste characteristics and compositions used in the SAM are derived from five existing data bases, recent field data, and RCRA waste listing background documents. It should be noted that the model waste compositions defined in Appendix C, Section C.2.2, of Reference 5 are not used in any way in the waste characterization file or to estimate uncontrolled emissions from the industry facilities. Section D.2.2 of this appendix contains information on the development and use of the WCDB.

D.1.5 Chemical Properties File

Emission estimation on a chemical constituent basis for each of the more than 4,000 TSDF waste constituents identified in the data bases was not possible because of a lack of constituent-specific physical and chemical property data and because of the sheer number of chemicals involved. Therefore, to provide the emission models with the relevant constituent physical, chemical, and biological properties that influence emissions and still maintain a workable and efficient method of estimating emissions, waste constituent categorization was required. As a result, TSDF waste constituents were grouped into classes by volatility (based either on vapor pressure or Henry's law constant, depending on the waste management unit process and emission characteristics) and by biodegradability. Surrogate categories were then defined to represent the actual organic compounds that occur in hazardous waste streams based on the various combinations of vapor pressure (four classes), Henry's law constant (three classes), and biodegradability (three classes). The surrogates substitute for the particular waste constituents (in terms of physical, chemical, and biological properties) in the emission calculations carried out by the SAM.

D.1.6 Emission Factors File

For each waste management process (e.g., an aerated surface impoundment), a range of model unit sizes was developed in order to estimate emissions. However, because specific characteristics of these model units were unknown, a "national average model unit" was developed to represent each waste management process. Each national unit is a weighted average of the nationwide distribution of process design parameters (e.g., unit capacity), using the nationwide frequency distribution of each model unit size as the basis for weighting. For each model unit, its emission factor (emissions per megagram of waste throughput) is multiplied by the appropriate weighting factor. The sum of these products results in a weighted emission factor for each national average model unit. The weighted emission factors were then compiled into an emission factor file for use in the SAM emission estimates. The SAM multiplies the annual quantity of organic compound processed (or passed) through the unit by the appropriate weighted emission factor for the surrogate (constituent) and management process, identified in the Industry Profile, to calculate the amount of organic compound that is emitted to the air or that is biodegraded. Because wastes may flow through a series of process units, a mass balance is performed for each waste management process unit to account for organics lost to volatilization and biodegradation in the unit; the revised organic content is then used to estimate the emissions for the next downstream unit.

D.1.7 Control Strategies and Test Method Conversion Factors

As a tool for evaluating control strategies or regulatory options, the SAM was designed to calculate environmental impacts of any number of combinations of control technologies and control efficiencies which are part of an externally generated control strategy. For example, controls can be applied based on the emission potential of the incoming waste stream; in this case, emission potential is defined as the VO content of the waste stream. The SAM can test the stream for VO content and apply, from an established file, VO test method conversion factors to the stream to estimate the VO concentration a particular test method would detect. The waste stream VO content can then be compared to a preselected VO action level (concentration limit) to determine if controls are to be applied to the waste stream. If the waste stream exceeds the VO action level, it is controlled as part of the TSDF control strategy. The SAM then estimates emissions from each controlled management process with the appropriate technology in place. The SAM can calculate emissions in a variety of formats. Emission estimates can be presented by waste management process, waste code, waste form, and volatility class, on a nationwide level.

D.1.8 Cost and Other Environmental Impact Files

Data files have also been assembled for calculating controlled emissions, control costs, and other environmental impacts. Files were developed for the SAM that provide control efficiencies, capital investment, and annual operating costs for each control option that is applicable to a particular waste management process. Cross-media and secondary impacts for the control options are calculated external to the SAM. These are the environmental impacts that result from implementation of the air pollution control option (e.g., solid wastes generated through use of control techniques such as carbon adsorption). For cost, cross-media, and secondary impacts, control option impacts are calculated as a function of the waste quantities identified in the Industry Profile. Impact estimates were developed for a national average model unit that reflects the general frequency of national unit size characteristics for each waste management process. The impact estimates are divided by the model unit throughput to obtain a factor from which nationwide impacts are computed. Multiplying facility throughput for the management unit by the appropriate impact factor results in an estimate of the impact for the particular unit. These impacts are summed to yield national estimates.

D.1.9 Incidence and Risk File

The SAM incidence and risk file contains exposure level coefficients to estimate annual cancer incidence and maximum lifetime risk (MLR) for the population within 50 km of each TSDF. The coefficients were developed using the Human Exposure Model (HEM) with 1980 census population distributions, local meteorological/climatological STAR data summaries, and an assumed emission rate (10 Mg/yr) and unit risk factor (1 case/μg/m^3/person). The SAM facility-specific incidence and risk coefficients can be scaled by annual facility emissions and the appropriate unit risk factor to give health impact estimates that reflect the level of emissions resulting from a particular emission scenario or control option. For a more detailed examination of incidence and risk determinations, see Appendix E of Reference 5.

D.2 INPUT FILES

D.2.1 Industry Profile Data Base

D.2.1.1 Introduction. As an initial input to the estimation of air emissions, an Industry Profile was developed to characterize TSDF waste management practices. The Industry Profile is based on data from the Westat Survey and from EPA's HWDMS. Data from the Office of Solid Waste's (OSW) 1986 Screener, which reflect 1985 TSDF activities, are also used heavily.

The following sections describe the Industry Profile contents and outline the data base sources. Discussion centers on the current Industry Profile of 2,336 TSDF. Section D.2.1.2 describes the data base structure and contents, Section D.2.1.3 documents selection of the SAM TSDF universe, and Section D.2.1.4 reviews data sources.

D.2.1.2 Data Base Contents. Table D-1 lists the variables in the current Industry Profile. Each record in the Industry Profile constitutes a single waste stream. A facility may have several different waste streams. The variables following the waste code indicate quantities and management methods for TSDF operations. All quantities are expressed in megagrams per year (Mg/yr).

Table D-2 gives an example record of an Ohio TSDF with EPA identification number OHD000000000 (variable FCID). Its primary SIC code is designated as 2879 (SIC1, Pesticides and Agricultural Chemicals). Table

TABLE D-1. INDUSTRY PROFILE DATA BASE CONTENTS[a]

Variable	Description
FCID	EPA 12-digit facility identification number
SIC1	Primary 4-digit standard industrial classification (SIC) code
WSTCDE	EPA hazardous waste number (RCRA waste code)
WAMT	Amount of waste for WSTCDE (Mg/yr)
QTYSTR	Amount of waste stored (Mg/yr)
TYPSTR	Storage process(es) - one of 20 potential process combinations[b]
QTYTX	Amount of waste treated (Mg/yr)
TYPTX	Treatment process(es) - one of 19 potential process combinations[b]
QTYDIS	Amount of waste disposed (Mg/yr)
TYPDIS	Disposal process(es) - one of 11 potential process combinations[b]
SOURCE	Source of data for waste quantities, RCRA codes, and management methods
ELIGSTAT	Facility status
LATT	Latitude (expressed in degrees, minutes, seconds, and tenths of seconds)
LONG	Longitude (expressed in degrees, minutes, seconds, and tenths of seconds)

RCRA = Resource Conservation and Recovery Act.
Mg = Megagrams.

[a] This table identifies and describes those variables of the Industry Profile data base used to characterize treatment, storage, and disposal facilities in nationwide impacts modeling.

[b] Hazardous waste management process combinations are presented in Table D-3.

TABLE D-2. INDUSTRY PROFILE DATA BASE - EXAMPLE RECORD[a]

Variable	Contents
FCID	OHD000000000
SICC1	3879
WSTCDE	D001[b]
WAMT	1056954
QTYSTR	1056954
TYPSTR	1
QTYTX	1056954
TYPTX	10
QTYDIS	0
TYPDIS	0
SOURCE	2
ELIGSTAT	7
LATT	3115000
LONG	08758000

[a] An example record of how one facility waste stream would appear in the Industry Profile data base.

[b] D001 = ignitible waste. Source: 40 CFR 261.21, Characteristic of ignitibility.

Ignitible wastes identified as D001 (WSTCDE) are managed at this facility. This TSDF manages (WAMT) and stores (QTYSTR) 1,056,954 Mg of waste D001 in a tank (TYPSTR = 1--see Table D-3), but it also treats the same amount (QTYTX = 1,056,954 Mg) in a tank (TYPTX = 10--see Table D-3). No quantity of this waste is disposed of (QTYDIS and TYPDIS, respectively). The data source for the RCRA waste code, its fraction of the total TSDF waste quantity, and its management processes may have come from EPA's HWDMS (SOURCE = 2, 3, or 4). Another source of such data may include the Westat Survey (SOURCE = 1). OSW's 1986 Screener (SOURCE = 5 or 6) provided the total waste quantity managed in 1985--from which the waste code quantity was derived--along with verification of waste management processes active in 1985. The facility operating status code (ELIGSTAT) indicates the TSDF is an active TSDF, ELIGSTAT = 7 (former TSDF, ELIGSTAT = 1; or closing TSDF, ELIGSTAT = 3). Latitude (LATT) of the site is 31 degrees, 15 minutes, and no seconds, and the longitude (LONG) is 8 degrees, 75 minutes, and no seconds.

The Industry Profile contains the following waste management processes found under variables TYPSTR (storage), TYPTX (treatment), and TYPDIS (disposal):

- Storage in a container (S01), tank (S02), wastepile (S03), or surface impoundment (S04)
- Treatment in a tank (T01), surface impoundment (T02), incinerator (T03), or other process (T04)
- Disposal by injection well (D79), landfill (D80), land application (D81), or surface impoundment (D83).

A variety of management process combinations may occur at facilities, some of which one would expect to find in parallel or in series. Where a series representation in the Industry Profile is not appropriate, the SAM is programmed to divide streams evenly between or among the listed processes. All potential process combinations found in the Industry Profile are listed in Table D-3 with the assigned divisions. The processes in column 2 become the parallel or series-parallel processes in column 3. Note that T04 ("other treatment") is listed separately, but its emissions are calculated on the basis of T01 (treatment tanks) operation. T03 (incineration) and D79 (injection well) are listed, but the SAM only calculates their transfer

TABLE D-3. INDUSTRY PROFILE REFERENCE KEY FOR WASTE MANAGEMENT PROCESS COMBINATIONS[a]

Combination number	Process code description[c]	Waste flow used in modeling simulation
Storage Processes (variable TYPSTR in Table D-1)		
0	No storage	No Storage
1	S02 only	→ S02
2	S01 only	→ S01
3	S04 only	→ S04
4	S03 only	→ S03
5	Other storage	→ S01
6	S01, S02	→ S01 → S02
7	S01, S04	→ S01 → S04
8	S01, S02, S03	→ S01 → S02 → S03
9	S01, S03	→ S01 → S03
10	S01, S02, S04	→ S01 → S02 → S04
11[b]	S01, S04	→ S01 → S04
12[b]	S01, S03, S04	→ S01 → S04 → S03
13[b]	S04, sump	→ S04
14[b]	S02, other	→ S02 → S01
15	S03, S04	→ S03 → S04
16	S02, S03	→ S02 → S03
17[b]	S02, S03, S04	→ S02 → S03 → S04

See notes at end of table. (continued)

TABLE D-3 (continued)

Combination number	Process code description[c]	Waste flow used in modeling simulation
Storage Processes (con.)		
18	S02, S04	→┬→ S02 └→ S04
19[b]	S01, S02, S03, S04	→┬→ S01 → S02 ├→ S03 └→ S04
20	S01, S02	→┬→ S01 └→ S02
Treatment Processes (variable TYPTX in Table D-1)		
0	No treatment	No treatment
1	T01 only	→ T01
2	T02 only	→ T02
3	T03 only	→ T03
4	T04 only	→ T04
5	T01, T02	→ T01 → T02
6[b]	T01, other	→ T01 → T04
7[b]	T01, other	→ T01 → T04
8	T01, T03	→┬→ T01 └→ T03
9[b]	T03, other	→┬→ T03 └→ T04
10	T01, T02, T03	→┬→ T01 → T02 └→ T03
11[b]	T01, T03, other	→┬→ T01 → T04 └→ T03
12	T02, T03	→┬→ T02 └→ T03
13	T02, T04	→ T02 → T04

See notes at end of table. (continued)

TABLE D-3 (continued)

Combination number	Process code description[c]	Waste flow used in modeling simulation
Treatment Processes (con.)		
14[b]	T01, T02, T03, T04	→ ┌→ T01 → T02 → T04 └→ T03
15	T01, T04	→ T01 → T04
16	T03, T04	→ ┌→ T03 └→ T04
17	T01, T02, T04	→ T01 → T02 → T04
18	T01, T03, T04	→ ┌→ T01 → T03 └→ T04
19	T02, T03, T04	→ ┌→ T02 → T04 └→ T03
Disposal Processes (variable TYPDIS in Table D-1)		
0	No disposal	No disposal
1	D79 only	→ D79
2	D80 only	→ D80
3	D83 only	→ D83
4	D81 only	→ D81
5	Other	→ D80
6	D81, D83	→ ┌→ D81 └→ D83
7	D80, D83	→ ┌→ D80 └→ D83
8[b]	D79, D83	→ ┌→ D79 └→ D83
9[b]	D79, D81	→ ┌→ D79 └→ D81
10	D80, D81	→ ┌→ D80 └→ D81

See notes at end of table. (continued)

TABLE D-3 (continued)

Combination number	Process code description[c]	Waste flow used in modeling simulation
Disposal Processes (con.)		
11	D79, D80	→ D79 → D80

[a] This table presents the various combinations of processes a waste code may pass through at a facility. Column 3 depicts how waste code combinations are interpreted to simulate actual facility processing steps in the Source Assessment Model. In many cases, it is unlikely that processes occur in series due to the physical form of the waste or the type of process; therefore, many management trains are interpreted in the model as having one waste pass through processes in parallel.

[b] Sources currently are not found in the Industry Profile data base but could potentially occur.

[c] Process code descriptions:[6]

Storage		Treatment		Disposal	
S01	Container	T01	Tank	D79	Injection well
S02	Tank	T02	Surface impoundment	D80	Landfill
S03	Wastepile	T03	Incinerator	D81	Land treatment
S04	Surface impoundment	T04	Other	D83	Surface impoundment

and handling emissions. This is because a separate Agency program is under way to regulate air emissions from hazardous waste incineration and because there are no process air emissions from injection wells.

The Industry Profile also contains RCRA waste codes as defined in Title 40, Part 261, of the Code of Federal Regulations (CFR).[7] The data base contains over 450 waste codes and includes "D," "F," "K," "P," and "U" RCRA codes. Hazardous waste codes are described in more detail in Chapter 3.0.

D.2.1.3 Establishing the SAM Universe of TSDF. The 1986 Screener surveyed over 5,000 potential TSDF. The Screener identifies 2,221 "active" TSDF to be characterized in the SAM. An active facility treated, stored, disposed of, or recycled waste during 1985 that was considered hazardous under Federal RCRA regulations. Active facilities include TSDF filing for closure if the facility managed some waste in 1985. The Screener designates as "inactive" those facilities that fall into any of three other categories:

- Former TSDF that have ceased all hazardous waste management operations
- TSDF that are closing and did not manage waste in 1985
- Facilities that do not treat, store, dispose of, or recycle hazardous waste.

Active Screener TSDF that are not currently addressed in the SAM were excluded. Excluded TSDF represent:

- TSDF that manage polychlorinated biphenyls (PCB)--a waste that is currently not RCRA hazardous
- TSDF whose waste is hazardous under State RCRA regulations but not under Federal RCRA rules
- TSDF that treat waste in units exempt from RCRA or store it under the 90-day rule (40 CFR 262.34(a))[8] and. therefore, do not require RCRA permits

TSDF whose total waste amount managed (including storage, treatment, and disposal) is less than 0.01 Mg/yr (about 340 TSDF) were considered small potential emitters and were also excluded from the SAM to improve data base manageability. A total of about 340 TSDF were excluded due to either

0.01-Mg/yr cutoff or because they only managed State-designated hazardous waste. Another nine active TSDF were excluded from the Industry Profile because all available data are classified as Confidential Business Information (CBI). The impact on nationwide waste volume from these nine TSDF is considered small due to their low volumes (less than 0.5 percent of the waste volume managed nationwide).

In addition to currently active TSDF, former or closing TSDF that had land disposal operations were also profiled. This is because of the potential source for air emissions from TSDF closed with waste left in place. The Westat Survey, HWDMS, and 1986 Screener identified 115 TSDF with former or closing land disposal operations. Therefore, the total universe for the SAM was set at 2,336 TSDF (2,221 active TSDF plus 115 closing or former TSDF).

D.2.1.4 Data Sources. The Industry Profile represents a composite of waste-stream-specific information collected from the 1986 Screener, the Westat Survey, and HWDMS. This section describes each of these sources. Waste stream data for each facility were derived from these sources as shown in Table D-4.

TABLE D-4. INDUSTRY PROFILE DATA BASE: DISTRIBUTION OF FACILITIES AMONG DATA SOURCES[a]

Data source	Number of active TSDF	+	Number of closed or former TSDF with land disposal units	=	Total TSDF
Westat Survey	438		27		465
HWDMS	1,361		85		1,446
1986 Screener	422		3		425
Total	2,221		115		2,336

TSDF = Treatment, storage, and disposal facility.
HWDMS = Hazardous Waste Data Management System.

[a] This table shows the number of facilities for which each Industry Profile data source provides waste stream information.

The 1986 Screener was used to identify the universe of regulated TSDF and their waste quantities managed annually. The Screener data base contains the most current data on TSDF operations--data from the year 1985. However, specific waste codes and the processes by which they are managed at each facility are not contained in the data base. Therefore, two other sources of waste code data were used. The Westat Survey was the preferred data source for assigning RCRA waste codes and management processes and distributing waste quantities by process. But due to the Westat Survey's limited sample of 831 TSDF, it was necessary to access the HWDMS RCRA Part A permit application data. The 1986 Screener was also used to verify management processes in operation and describe a TSDF's waste streams and management processes if the Westat Survey or the HWDMS data did not contain the information needed.

The Westat Survey and the HWDMS were used as initial inputs to assigning an SIC code to each facility. Section D.2.1.4.4 outlines additional sources used to determine a facility's principal business activity.

D.2.1.4.1 1986 Screener data. The goals of using the 1986 Screener data were threefold: (1) to identify which TSDF should be included in the SAM, (2) to profile 422 active TSDF identified by the Screener but not included in the HWDMS or the Westat Survey, and (3) to update the total waste quantity by TSDF to reflect 1985 data.

As a first goal, the Screener data on TSDF operating status were compared to the Industry Profile list of active and closed facilities. Any inconsistencies in the profile were revised, using the 1986 Screener information as the most current source of data.

The second goal--to profile the additional Screener TSDF--entailed adapting the Screener data to make them compatible with the HWDMS and the Westat Survey. The 1986 Screener does not refer to individual RCRA waste codes but rather to general waste types: acidic corrosives, metals, cyanides, solvents, dioxins, other halogenated organics, and other hazardous waste. Also, management processes listed in the Screener differ slightly from the processes cited in the HWDMS and the Westat Survey. For instance, the 1986 Screener does not list storage in tanks or containers, specifically. Rather, these are combined in a category listed as "other storage."

To adapt these Screener data, default waste categories were developed to replace RCRA waste codes, and management process descriptions were converted to RCRA process codes. For example, the 1986 Screener waste type "acidic corrosives" was assigned to a default RCRA waste code of D002 (corrosive waste). Cyanides were assigned to D003 (reactive waste). (Section D.2.2.10 describes the development of default waste compositions.) For waste management processes, most process code assignments were straightforward; however, some process descriptions were not. For example, the Screener's wastewater treatment category was assigned the process code T01 (treatment in a tank) when not specified as exempt from RCRA regulation. Other processes included solidification, which was assigned T04 (other treatment), and "other storage," which was assigned a combination of S01 and S02 (storage in a container or tank).

After assigning management processes and RCRA waste codes to each facility, the next step used to develop Screener waste streams was to assign specific waste quantities to RCRA waste codes and management processes. Question 3 of the Screener indicated the total amount of waste that was treated, stored, or disposed of onsite in units regulated under RCRA at each facility. Quantity distributions were made based on information obtained from the 1986 Screener, telephone inquiries conducted by the Screener staff, and best engineering judgment.

The third goal in using 1986 Screener data was to update waste quantities (derived from the HWDMS or the Westat Survey) for the active TSDF. Screener Question 2 was used to identify the total quantity of hazardous waste that was treated, stored, or disposed of onsite in 1985 under Federal RCRA regulations. The 1985 total quantity of waste per facility was distributed among waste streams on a weight basis. 1985 distributions were made proportionate to the TSDF's distribution of waste code quantities used previously from either the HWDMS or the Westat Survey. For example, if a facility had a waste code quantity of 1,000 Mg and a total waste quantity for the facility of 2,000 Mg, the distribution of waste code to total waste quantity is 1,000/2,000 or 0.5. If Screener data indicate that the facility has a 1985 total waste quantity of 3,000 Mg, the waste code quantity is increased from 1,000 to 1,500 Mg to reflect its ratio to the facility's total waste quantity (0.5 multiplied by 3,000).

D.2.1.4.2 Westat Survey. Data were accessed from Westat's general questionnaire to identify facility waste streams. Question 12 asked for the total quantity of hazardous waste that the facility treated, stored, or disposed of onsite during 1981. Question 17 asked the facility to complete a table for the 10 hazardous wastes handled in largest volume in 1981. The table requested that the waste be listed by EPA waste code and include a breakdown of waste by specific management processes (e.g., tank, incinerator, wastepile) and by specific waste quantities for storage, treatment, and disposal. The Westat Survey is preferred to HWDMS as a data source because data reflect actual annual throughputs and waste management processes for TSDF. However, the data base covered only 831 TSDF. Of these, only 438 active and 27 closed TSDF were of interest. Also, data represent activities in the year 1981 and may no longer be accurate. Westat Survey data have been reviewed to exclude hazardous wastes that are exempt or excluded from RCRA regulation. The Westat Survey specifically excludes waste streams sent to publicly owned treatment works (POTW), waste from small quantity generators, wastes that are stored in containers or tanks for less than 90 days, wastewater treatment in tanks whose discharges are covered under National Pollutant Discharge Elimination System (NPDES) permits, and wastes that have been delisted by EPA even if the delisting occurred after 1981.[9]

D.2.1.4.3 HWDMS. HWDMS data, retrieved in October of 1985, consist largely of RCRA Part A permit application information. Existing TSDF were required to complete Part A of the permit application by November 19, 1980, in order to receive interim status to operate. The Part A permit asks the facility to list quantity of waste (by RCRA waste code) that will be handled on an annual basis and waste management processes that will be used.

HWDMS data have several disadvantages compared to Westat Survey data. Unlike the Westat Survey data, Part A reflects estimated, not actual, waste throughput and processes. Part A is a record of "intent to manage" waste. The HWDMS also does not break down the total amount of waste managed into quantities that were treated, stored, or disposed of, and the year for which data are provided is unknown. A facility may have submitted an amended Part A to reflect changes in waste types or quantities since 1980, but the date of submission cannot be ascertained. Finally, some waste streams may reflect processes that are exempt or excluded under RCRA, such as less than 90-day storage. These streams cannot be identified.

D.2.1.4.4 SIC codes development. Each of the TSDF in the Industry Profile was examined individually to determine a primary 4-digit SIC. In assigning SIC, the HWDMS and Westat Survey were used as initial points of reference, but because of the number of nonexistent codes and the abundance of only 2- or 3-digit SIC codes, each SIC was verified using all available reference sources.

Several steps were taken to assign an SIC code. The Standard Industrial Classification Manual[10] was used to identify SIC codes for TSDF when no code was provided in the data sources, and the facility's name, address, waste codes, and waste amounts were examined for identifying information. In many instances, this information was enough to assign an SIC. For example, a facility, Wood Preserving Company B, was assigned an SIC of 2491 (wood preserving industries). A facility with waste codes of K048-K052 would be assigned an SIC relating to the petroleum refining industries. Additional sources of information[11,12,13] provided corporate or plant descriptions. Also, the various census reports[14-18] were used to identify the number of facilities in each State with a given SIC code. For example, in trying to establish an SIC for Oil Service Company C in Arizona, waste codes were referenced first. No "K" waste codes were identified that related the facility to petroleum refining. Therefore, the Census of Manufactures[19] was consulted. It indicated zero petroleum refineries in Arizona. Oil Service Company C was assigned the SIC of 5172 (petroleum products not elsewhere classified).

D.2.2 TSDF Waste Characterization Data Base (WCDB)

D.2.2.1 Background. To support the development of air emission regulations for hazardous waste TSDF, a data base of waste characteristics was developed. Wastes listed in this data base were characterized, primarily using five existing data bases: (1) the Westat Survey,[20] (2) the Industry Studies Data Base (ISDB),[21] (3) a data base of 40 CFR 261.32 hazardous wastes from specific sources[22] (i.e., waste codes beginning with the letter K), (4) the WET Model Hazardous Waste Data Base,[23,24] and (5) a data base created by the Illinois EPA.[25] An additional source of data, EPA field reports on hazardous waste facilities, also was used. The WCDB makes no use of the model wastes defined in Appendix C, Section C.2.2, of Reference 5.

The Westat Survey data base contains the most extensive information on the physical/chemical form, quantity, and management of waste; therefore, it was selected to serve as the framework for the TSDF WCDB. This data base has been organized to present hazardous waste stream* information in the following series of categories:

- Primary SIC code
- RCRA waste code
- General physical/chemical waste form.

For each SIC code, Westat contains a list of waste codes. It then divides each waste code into physical/chemical forms such as inorganic sludges, organic liquids, etc. Westat also designates a waste quantity for each physical/chemical form of a waste code.

The remaining four data bases and EPA field reports were used to provide chemical composition data in the form of two additional data categories in the WCDB: "waste constitutents" and "percent composition of constitutents." Where information was not available for these two categories, a list of constitutents and their percent compositions was created (i.e., default composition) based on information found in the four data bases, field reports, RCRA waste listing background documents, and engineering judgment.

Table D-5 is an example of a hazardous waste stream in the WCDB. This example states that, in the commercial hazardous waste management industry (SIC code 4953), RCRA waste code U108 is managed as an organic liquid (form 4XX). Its composition is 90 percent 1,4-dioxane and 10 percent water.

D.2.2.2 Application to the Source Assessment Model (SAM). The SAM uses the WCDB to identify representative compositions for wastes managed at each TSDF. SAM uses these compositions to estimate organic emissions based on waste constituent concentrations and their volatility. The procedure is described in the following paragraphs.

---

*For discussion, a hazardous waste stream is a unique combination of SIC code, RCRA waste code, and physical/chemical form.

TABLE D-5. WASTE CHARACTERIZATION DATA BASE:
EXAMPLE WASTE STREAM RECORD[a]

SIC code	4953
Form code[b]	4XX
RCRA characteristic code[c,d]	T
RCRA waste code[d]	U108
Waste constituent/% composition	1,4-Dioxane/90% Water/10%

SIC = Standard industrial classification.
RCRA = Resource Conservation and Recovery Act.

[a] This table presents an example of the information found in the Waste Characterization Data Base for one waste stream managed in a given industry.

[b] Physical/chemical waste forms are coded as follows:

1XX = Inorganic solid
2XX = Aqueous sludge
3XX = Aqueous liquid
4XX = Organic liquid
5XX = Organic sludge
6XX = Miscellaneous.

[c] RCRA characteristic code reflects the hazard of the waste:

T = Toxic
C = Corrosive
I = Ignitible
R = Reactive.

[d] RCRA characteristic and waste codes listed in 40 CFR 261.33(f).[26]

The SAM initially reads the Industry Profile (described in Section D.2.1) for each TSDF's primary SIC code, RCRA waste codes, and the annual quantity of each code. It then searches the WCDB for this SIC and then for the TSDF's RCRA waste codes. Because the physical and chemical form of a waste code may vary, the chemical composition and emission potential will also vary. Therefore, for each waste code, the WCDB provides quantities from the Westat Survey data base by physical/chemical form of the waste code. The quantitative distribution of physical/chemical forms within a waste code is then applied to the Industry Profile waste code's quantity for that TSDF. For example, if the TSDF's profile has 150 Mg of D003 and the WCDB shows that D003 has 1,200 Mg of organic liquid and 600 Mg of organic sludge forms present across that SIC (i.e., a two-to-one ratio by form), the TSDF profile's 150 Mg is distributed two-to-one as 100 Mg of organic liquid and 50 Mg of organic sludge. This approach allows the most current waste quantity information to be used in a more detailed fashion, using distribution data from a more rigorous data source (Westat Survey).

Once form distributions are established, the SAM begins to search for chemical compositions to assess volatility and, in turn, emission potential of each waste code/form combination. The search proceeds as depicted in Figure D-2. Six discrete sets of waste composition data are identified in the figure:

- ISDB
- Field data
- Illinois EPA data base
- K Stream data base
- WET Model data base
- Data set consisting of default values.

The logic shown in Figure D-2 ranks these data sets in the order listed above to reflect the relative certainty in data representativeness. Thus, if a waste stream had more than one set of compositions to choose from, the SAM would use the highest ranking data base composition. The logic diagram does not include the Westat Survey constituents because no percent compositions were available.

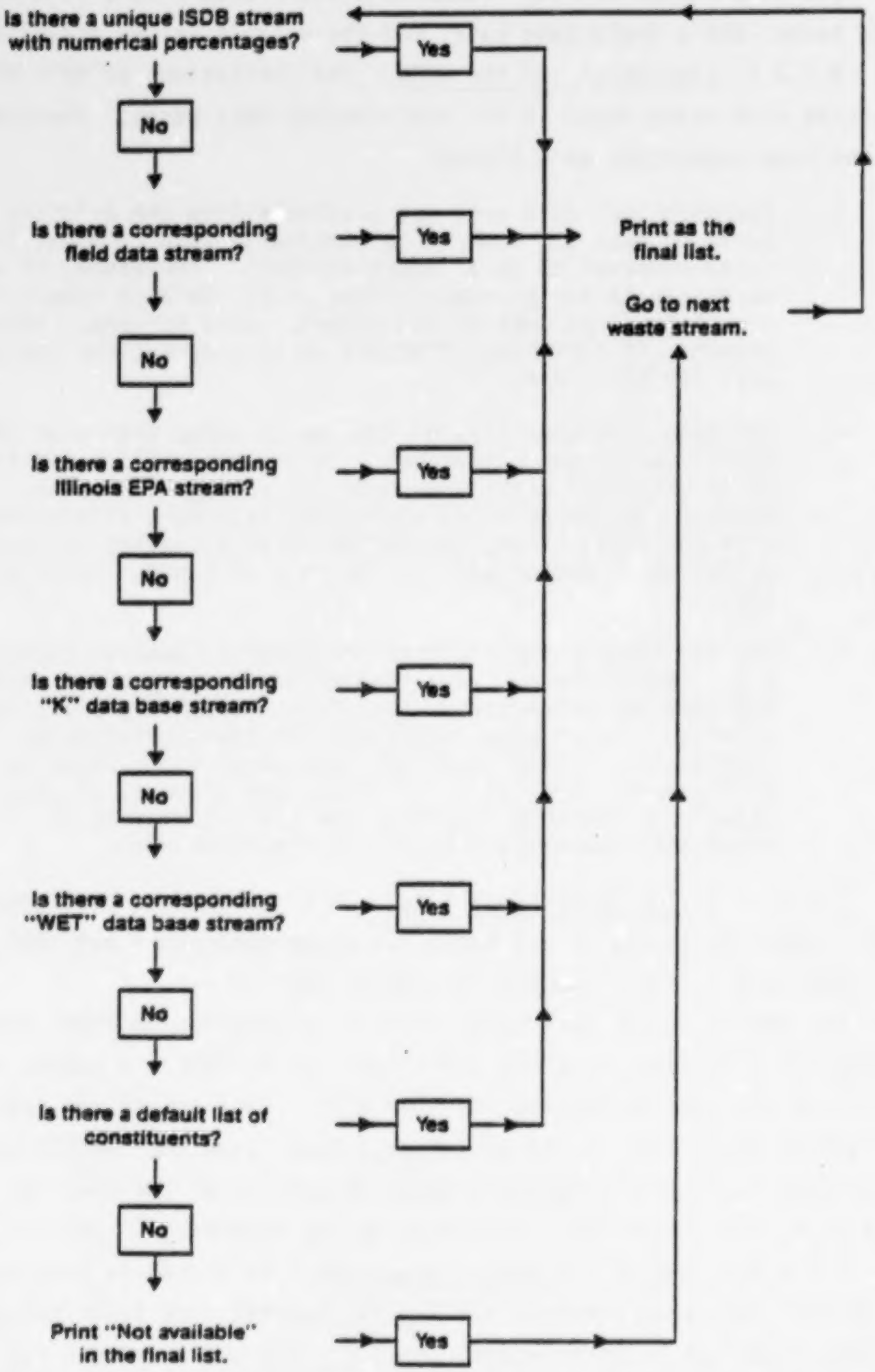
Is there a unique ISDB stream with numerical percentages?
Yes
No
Is there a corresponding field data stream?
Yes
Print as the final list.
Go to next waste stream.
No
Is there a corresponding Illinois EPA stream?
Yes
No
Is there a corresponding "K" data base stream?
Yes
No
Is there a corresponding "WET" data base stream?
Yes
No
Is there a default list of constituents?
Yes
No
Print "Not available" in the final list.
Yes

Figure D-2. Logic flow chart for selection of final list of waste constituents.

Sections D.2.2.4 through D.2.2.10 discuss each of the five existing data bases, EPA's field data base, and the default values established.

D.2.2.3 Limitations of the WCDB. The limitations of this WCDB coincide with those found in all contributing data bases. Therefore, some of the same weaknesses were shared:

- Compositional data were not available from the existing data bases on each SIC code/waste code/waste form combination (also referred to as a "waste stream"). Therefore, it was necessary to assign compositions (i.e., default compositions) to 30 percent of the organic waste streams. This reduces the certainty of actual waste compositions the SAM uses for SIC codes.
- The data base consisted of 1981 waste codes (the year the Westat Survey was conducted). It did not reflect additions to 40 CFR 261[27] since 1981 such as listing of dioxins. However, wastes delisted since 1981 have been eliminated from the WCDB. Thus, the SAM emission estimates reflect delisting of wastes but not the role of wastes listed since 1981.
- Certain organic constituents are generic chemical classes, e.g., "amino alkane," and thus do not have specific physical and chemical properties. Therefore, volatility and biodegradation classes were designated for these generics by referencing a common chemical considered representative of that generic chemical. Therefore, the presence of generic classes in the WCDB decreases the SAM's certainty of predicting appropriate emissions from that class.

D.2.2.4 Westat Survey Data Base. This survey data base compiles data from a 1981 EPA survey of all hazardous waste generators and TSDF. Use of the data base for this project focused on TSDF only.

The Westat Survey data base contains information on TSDF from approximately 230 SIC codes, covering active and closed TSDF. A subset of the data base was used to develop the TSDF WCDB. This subset represents only the active facilities in the Westat data base (covering 182 SIC codes). The active facilities constitute about 70 percent of the complete Westat data base, and closed facilities make up the remaining 30 percent.

D.2.2.4.1 Use of the Westat data base. As stated in Section D.2.2.1, the Westat data base provides the SAM (1) quantitative distributions of physical/chemical forms of waste codes, and (2) the framework for the SAM to track a waste code to an appropriate chemical composition in the WCDB.

(Compositions are selected from the data bases described in Sections D.2.2.5 through D.2.2.10.)

The WCDB uses Westat waste stream information such as facility SIC code, RCRA waste codes managed, and physical/chemical forms of waste codes (i.e., waste streams). This information is organized by SIC so that data can be applied to any TSDF in the Industry Profile with that SIC code.

The WCDB and the SAM use the following Westat data base categories:

- SIC code--Primary SIC code of the survey respondent. If the respondent's primary SIC code was 2-digit, e.g., 2800, the more detailed, secondary SIC code listed by the respondent was used when available, e.g., 2812. (For all remaining 2-digit codes, more descriptive 4-digit codes were assigned to the WCDB based on knowledge of the TSDF's industrial operations.)

- RCRA waste code--Survey respondents were asked to list the 10 largest waste streams (by RCRA waste code) managed at each TSDF. Thus, for each SIC code, TSDF respondents with a matching SIC will have their top 10 waste codes listed.

- Physical/chemical waste form--Survey respondents were also asked to describe the physical/chemical character of each of the 10 waste streams. Based on these descriptions, the physical/chemical forms were classified as follows:

1XX	Inorganic solid	4XX	Organic liquid
2XX	Aqueous sludge	5XX	Organic sludge/solid
3XX	Aqueous liquid	6XX	Miscellaneous

  Therefore, within a SIC's waste code, one will find as many as six forms of that waste code.

- Physical/chemical waste form quantity--The quantity of each physical/chemical form of a waste code managed within each SIC code. (Note: These form quantities are mutually exclusive of each other and may be added.) If more than one TSDF reported the same form of waste code, their quantities were added to provide an indication of the volume of that stream managed by the TSDF population having a common SIC code.

D.2.2.4.2 Westat Survey Data Base limitations. Certain limitations of the Westat Survey data base that may affect the SAM results are discussed below:

- Several survey respondents identified wastes by using more than one waste code. The EPA entered these streams into the Westat data base as X---codes. For the WCDB, the X codes were translated into their respective D, F, K, P, and U waste codes, and the first code listed from the multiple codes was used in the WCDB. For example, if X002 is a combination of F003 and F005, then F003 was used in the WCDB. Not knowing which code best represented a waste increased the uncertainty of waste compositions used in the SAM.

- Individual waste streams were not always keyed to their most descriptive SIC code. The WCDB identifies waste streams by the primary SIC code listed by a TSDF. Consequently, it is possible that a waste stream will be identified by the facility's primary SIC code when another SIC code is more descriptive. To correct this limitation, the most descriptive SIC codes were chosen following an Industry Profile review of facility SIC codes.

- Invalid or missing codes were found in the Westat data base. For example, the Westat data base may have no SIC codes listed for some TSDF, invalid RCRA waste codes listed such as "D000, 9995, 9998, 9999, Y---," and no physical/chemical form of waste listed.

  To examine those Westat Survey waste streams with invalid waste forms and waste codes (9999, etc.), a list of such codes was generated. Then, it was decided to remove some of these streams from the WCDB and reassign real waste codes to the remaining streams based on an examination of waste constituents and waste form. The following summarizes steps taken to resolve invalid waste codes and forms:

  -- For invalid waste codes:

    --Streams <18.9 Mg (5,000 gal) were not included in the WCDB.

    --Streams <18.9 Mg but containing PCB were reassigned.

    --Streams >18.9 Mg but containing no constituent information were not included.

    --Streams >18.9 Mg and having useful constituent information were reassigned.

  -- For waste streams with no physical/chemical form listed:

    --Streams <18.9 Mg were not included in the WCDB.

--Streams having no constituents were not included.

--Management method(s) were reviewed for a clue as to the liquid, sludge, or solid state. Then, physical/chemical forms were assigned to such streams.

D.2.2.5 Industry Studies Data Base. The ISDB is a compilation of data from EPA/OSW surveys of designated industries that are major hazardous waste generators. The ISDB version used addresses eight SIC codes:

- Industrial inorganic chemicals - alkalies and chlorine (SIC 2812)
- Industrial inorganic chemicals - not elsewhere classified (SIC 2819)
- Plastics materials, synthetic resins, and nonvulcanizable elastomers (SIC 2821)
- Synthetic rubber (SIC 2822)
- Synthetic organic fibers, except cellulosic (SIC 2824)
- Cyclic crudes, and cyclic intermediates, dyes, and organic pigments (SIC 2865)
- Industrial organic chemicals, not elsewhere classified (SIC 2869)
- Pesticides and agricultural chemicals, not elsewhere classified (SIC 2879).

Data on other SIC codes are being developed by the EPA/OSW and could be added in the future. Information in the ISDB was gathered from detailed questionnaires completed by industry, engineering analyses, and a waste sampling/analysis program. The data base contains detailed information on specific TSDF sites. Because of the confidential nature of much of the data, waste information was provided in a nonconfidential form to allow its use; e.g., generic chemical constituent names such as "amino alkane" were used where specific constituents were declared confidential.

D.2.2.5.1 Use of the ISDB. The WCDB contains ISDB waste composition data. The WCDB uses the ISDB SIC code, waste code, and its physical/chemical waste form to track and identify waste stream compositions. It then uses the waste form's quantity in the ISDB to normalize constituent concentrations across multiple occurrences of the same waste stream. The SAM uses the ISDB composition data via the WCDB for TSDF with those SIC codes listed in the previous subsection. The SAM uses the following ISDB waste composition data:

- Constituents--The ISDB provides chemical constituents contained in an SIC code's waste code/waste form combination, i.e., a waste stream. The stream data have been compiled in a way that makes all information nonconfidential.
- Normalized constituent concentrations--Weighted average constituent concentrations were calculated for each of the constituents to yield a normalized waste stream composition. Normalizing sets all total constituent concentrations to 100 percent.

D.2.2.5.2 ISDB limitations. The ISDB used in the WCDB provided useful waste composition data not only for direct use in the SAM but also to fill data gaps in the WCDB, e.g., to create default compositions for SIC codes where waste compositions were not available. However, it is necessary to identify some limitations of the ISDB:

- The petroleum refining industry--one of the top five industry generators--was not available for the ISDB version used. The EPA/OSW surveyed this industry (SIC code 2911), but questionnaire responses were not accessible from the data base at the time. However, some raw field data were provided for the industry under the ISDB program. This is discussed in Section D.2.2.6. For waste streams with no field data, K stream data and default compositions were used.
- The ISDB used a larger number of more specific waste forms than the WCDB. To make the data more consistent with the WCDB, it was necessary to condense the ISDB list of waste forms to the six WCDB forms listed in Section D.2.2.4.1. This task was straightforward with most categories.
- The ISDB contains confidential business information. To use the ISDB waste characterization, its confidential data had to be made nonconfidential beforehand. As a result, the printout frequently did not identify RCRA D, K, P, and U waste codes. For example, instead of printing "K054," ISDB used "KXXX." It was possible to determine that DXXX represented D004 to D017 because ISDB did list D001, D002, and D003. However, the large number of K, P, and U waste codes

would not permit use of protected ISDB KXXX, PXXX, and UXXX compositional data as used for DXXX. Thus, this led to an increased use of default compositions by the SAM.

- The percent composition of waste stream constituents was sometimes listed as "unknown." In these cases, their concentrations were designated as zero because the other constituents with known concentrations typically added up to nearly 100 percent. This was considered to have a minimal impact on the SAM results.
- The number of participants in the ISDB program was small. However, the ISDB was considered the most thorough and accurate of the five data base sources and therefore was used in many respects such as in the development of D code default compositions.
- The waste constituents were often nonspecific, i.e., the ISDB listed constituents as generic chemicals such as "amino alkane." In these cases, a common chemical considered representative of the generic chemical was chosen so that the SAM could assign volatility and biodegradation classes to the constituent. Therefore, the presence of the generic chemical classes in the WCDB decreases the SAM's certainty of predicting appropriate emissions from that class.

D.2.2.6 New Field Test Data.

D.2.2.6.1 Data base description. This data base is a collection of waste composition data developed from the review of a hazardous waste TSDF process sampling report[28] and petroleum refining test data from the OSW listing program. It contains waste data from three industries:

- Petroleum refining (SIC 2911)
- Electroplating, plating, polishing, anodizing, and coloring (SIC 3471)
- Aircraft parts and auxiliary equipment, not elsewhere classified (SIC 3728).

This data base contains detailed information from specific TSDF sites.[29,30,31] The petroleum refining data were collected as part of the Industry Studies survey; however, they were not accessible through the ISDB.

D.2.2.6.2 Use of the data base. The WCDB contains this data file's waste compositions. It uses the file's SIC code, waste code, and waste form to track and identify compositions. The data file contains the nine waste streams listed in Table D-6.

D.2.2.6.3 Data base limitations. The two sampling reports and the petroleum refining test data used to create the field data base did not always label waste stream information with RCRA waste codes. Therefore, it was necessary to assign waste codes and waste forms to stream compositions based on the reports' descriptions of sampling points and waste compositions. This may limit the certainty that the SAM uses the most representative waste compositions for waste codes.

The specific organic constituents for these nine streams were so numerous and so small in concentration that it was decided to reduce the chemicals to the following categories:

- Total paraffins
- Total aromatic hydrocarbons
- Total halogenated hydrocarbons
- Total oxygenated hydrocarbons
- Total unidentified hydrocarbons (includes oil)
- Total nonmethane hydrocarbons.

Some of these categories were already present in the TSDF chemical universe. Unidentified hydrocarbons proved to be the largest concentration category among waste streams because of their oil content.

D.2.2.7 Illinois EPA Data Base.

D.2.2.7.1 Data base description. Before an Illinois TSDF can accept RCRA wastes, they must obtain a permit from the Illinois EPA's Division of Land/Noise Pollution Control. For each waste, the applicant must detail its generation activities and provide analysis of each waste. The Illinois EPA has compiled this permit information in a data base. It contains waste compositions for RCRA hazardous and special nonhazardous waste streams from large quantity generators (>1,000 kg generated per month) in the State of Illinois and other States that ship wastes to Illinois TSDF for management. The data base used contained 35,000 permits.

TABLE D-6. WASTE STREAMS BY INDUSTRY IN THE FIELD TEST DATA[a]

SIC code	Industry	Waste code[b]	Waste form[c]
3471	Electroplating	D002	3XX[d]
3728	Aircraft Parts	D002	3XX[d]
2911	Petroleum Refining	D002	3XX[d]
2911	Petroleum Refining	D006	2XX
2911	Petroleum Refining	D007	2XX
2911	Petroleum Refining	K048	5XX
2911	Petroleum Refining	K049	5XX
2911	Petroleum Refining	K051	5XX
2911	Petroleum Refining	K052	2XX

SIC = Standard industrial classification.
WCDB = Waste Characterization Data Base.

[a] This table summarizes those waste streams compiled in a data base of field test results.[32,33] It reflects the industry tested and the waste code/form combinations tested and notes decisions made on how to use the data as part of the WCDB.

[b] Waste codes listed in 40 CFR 261, Identification and Listing of Hazardous Waste, Subpart C, Characteristics of Hazardous Waste, and Subpart D, Lists of Hazardous Wastes.[34]

[c] Physical/chemical waste forms are coded as follows:

1XX = Inorganic solid
2XX = Aqueous sludge
3XX = Aqueous liquid
4XX = Organic liquid
5XX = Organic sludge
6XX = Miscellaneous.

[d] The field data contained only a very small percentage of organic constituents; therefore, these organics were inserted into the existing WCDB compositions, normalizing the original[35] organics to maintain the original total organic percent composition.

D.2.2.7.2 Use of the data base. The Illinois EPA data used for this program contained the following information pertinent to the WCDB:

- Generator SIC code (most of the codes on file were assigned by the State)
- RCRA waste code(s)
- Physical phase of waste
- Waste composition (states whether the waste was organic or inorganic)
- Key waste stream constituents by name and percent composition.

A total of about 4,000 SIC code/waste code combinations were evaluated for incorporation into the WCDB. These 4,000 records reflect over 250 SIC codes.

D.2.2.7.3 Data base limitations. The Illinois EPA data expanded the volume and quality of information used in the WCDB. However, certain limitations were noted when the data were collected and organized:

- Only those permits listing RCRA waste codes were used in the WCDB. (This excluded the special nonhazardous wastes and hazardous waste permits with incomplete or no RCRA waste codes.) This ensures that only the most accurate waste data are used.
- Only Illinois waste permits listing just one RCRA code were incorporated into the WCDB. A large number of Illinois EPA permits contained more than one RCRA waste code. This decision decreased the usage of the Illinois EPA data, but those data used were considered higher in quality.
- Only those permits for which SIC codes could be identified were incorporated into the WCDB, for without SIC codes a waste composition cannot be properly assigned to its most appropriate generating industry. Most of the SIC codes found in the Illinois EPA data base were assigned by the State, not the waste permit applicant. All remaining records that were missing SIC codes were identified. A list of these records was printed by generator name. Dun and Bradstreet's 1986 Million Dollar Directory[36] was researched to identify as many generators by company name and SIC code as possible. However, it was not possible to identify all of the companies' codes. Only those permits for which SIC codes could be identified were incorporated into the WCDB.

D.2.2.8 RCRA K Waste Code Data Base.

D.2.2.8.1 Use of the data base. The original K waste code data base developed by Environ[37] describes these codes in terms of waste stream constituents, constituent concentrations, and other waste characteristics such as specific gravity and reactivity or ignitibility. The data base was derived from a combination of RCRA listing background documents, industry studies, and open literature. Thus, it generally provides a range of concentrations for any given constituent in a waste stream.

A representative concentration for each constituent in a waste stream was needed to develop waste stream characteristics and calculate emissions. Because the Environ data base reported varying compositions from various sources, Radian[38] selected representative constituent concentrations from the ranges provided in that data base. The WCDB uses this file of representative constituent concentrations for the SAM. For example, a mean would be used for a range of concentrations originating from one data source. However, if the waste data came from two or more sources, a more elaborate procedure was necessary to determine representative constituent information. For waste data from two sources, Radian chose the highest concentration of each constituent found in the two sources and then normalized the waste composition to 1,000,000 parts. This may have resulted in above-average concentrations of constituents; however, the approach was selected to ensure that at least a representative average concentration was identified. For waste with three or more data sources, a check was made for outlying values, and the remaining data were averaged to obtain representative constituent concentrations if no mean were provided.

D.2.2.8.2 K Stream data base limitations. Although this data base contained compositional information on each RCRA K stream, it had two limitations:

- Some stream compositions totaled less than 100 percent and were therefore incomplete. In such cases, the WCDB considered the unidentified components inorganic.
- Some waste constituents appeared as generic chemical constituents, e.g., "other chlorinated organics." Volatility and biodegradation classes were designated for those generic constituents by referencing a common chemical considered representative of that generic constituent.

D.2.2.9 WET Model Data Base.

D.2.2.9.1 Data base description. This data base contains 267 waste streams. Data collection for this data base concentrated on industry sectors where the impact of the RCRA land disposal regulations may be most significant. Based on the preliminary regulatory impact analysis (RIA) for the land disposal regulations,[39] those industry sectors potentially impacted to the greatest degree and included in this data base are:

- Wood preserving (SIC 2491)
- Alkalies and chlorine (SIC 2812)
- Inorganic pigments (SIC 2816)
- Synthetic organic fibers (SIC 2823, 2824)
- Gum and wood chemicals (SIC 2861)
- Organic chemicals (SIC 2865, 2869)
- Agricultural chemicals (SIC 2879)
- Explosives (SIC 2892)
- Petroleum (SIC 2911)
- Iron and steel (SIC 331, 332)
- Secondary nonferrous metals (SIC 3341)
- Copper drawing and rolling (SIC 3351)
- Plating and polishing (SIC 3471, 3479).

The WET Model study investigated the appropriate level of control for various hazardous wastes by characterizing a manageable number of waste streams, a process requiring a considerable amount of approximation and simplification. This process achieved two major objectives.

The approach to waste characterization was to develop a series of comprehensive profiles for each hazardous waste stream using available data. In many cases, these profiles were developed from partial information using processes of approximation and extrapolation.

D.2.2.9.2 Use of the data base. The WCDB uses the following WET data:

- SIC code
- RCRA waste code
- Phase description, i.e., composition in terms of oil, nonaqueous liquids, water, and solids content
- Constituent concentrations.

D.2.2.9.3 WET data base limitations. The quality of the available data varied greatly and, in general, was not as adequate for the WCDB as other data bases for several reasons. Among the reasons are the following:

- Nontoxic hazardous wastes are excluded from the data base because the model is capable of assessing only the toxicity hazard. Therefore, waste compositions exclude nontoxic, volatile organics.
- Waste compositions may total less than 100 percent because the data might have been incomplete for particular waste streams due to lack of available source material, either in absolute terms or in the time frame of this project. Thus, missing waste constituents were considered inorganic.
- Data availability also might have been limited for particular industries where there were few generators, e.g., in the pesticide industry.
- The data might have been imprecise in the recording of specific information, e.g., the reporting of total chromium with no quantitative information on the concentration of hexavalent chromium, which is by far the more toxic agent.[40]

Because of the variability in the data quality for constituent concentration, this data base was considered of lesser quality than others and, therefore, used less.

D.2.2.10 WCDB Waste Composition Defaults. As previously stated, the ISDB, WET, K stream, Illinois EPA, and field data bases were used primarily to provide waste stream constituents and their percent of the stream's composition. Although these data bases were extensive, they did not address each and every SIC code/waste code/form combination found in the Westat Survey data base. Therefore, default waste compositions were developed to fill these data gaps. This section explains how these default compositions were developed.

The existing ISDB D code compositions were used to develop default compositions for each combination of D001/waste form, D002/waste form, D003/waste form, and DXXX (i.e., D004-D017)/waste form. For example, if the ISDB had compositions of D001/4XX from four SIC codes, the four sets of compositions were composited to create one D001/4XX default composition. Each time the SAM finds a TSDF managing D001/4XX whose SIC code does not contain the waste stream in the existing data sources, the stream is assigned the default composition.

It was also necessary to develop default compositions for F code/waste form combinations not in the existing data bases. The distribution of constituents for each of the following F streams was derived from a background document[41] to the 40 CFR 261 regulations that provides consumption data on those chemicals found in RCRA waste codes F001 to F005.

For F001, halogenated degreasing solvents, the background document states that trichloroethylene is the solvent used most prevalently.[42] Unlike F002 to F005, there is no summary of F001 consumption by specific chemical solvent. Therefore, trichloroethylene serves as the solvent each time an F001 code appears in the TSDF data base.

The consumption data in the background document provided a percentage solvent distribution for waste codes F002 to F005, as shown in Table D-7.

Although a single waste code stream would not contain all of the chemicals listed, the distribution shown in Table D-7 allows one to address all chemicals in a manageable way.

Once the distribution of solvents among waste codes was completed, it was necessary to assign compositions by waste form, e.g.:

Waste form _XX Waste code F _ _ _ % Solvents _____ _% Solvent 1
_____ _% Solvent 2
_____ _% Solvent 3
_____ _% Solvent 4

For waste forms 1XX (inorganic solid) and 2XX (aqueous sludge), general wastewater engineering principles[45] were applied:

TABLE D-7. PERCENTAGE DISTRIBUTION FOR WASTE CODES F002 TO F005[a]

Solvent waste codes[b] and respective chemicals	Quantity of chemical consumed as solvent annually (ca. 1980), 10^3 Mg/yr	Percent consumption
F002/Tetrachloroethylene	255.8	26.6
Methylene chloride	213.2	22.2
Trichloroethene	188.2	19.6
Trichloroethane	181.4	18.9
Chlorobenzene	77.1	8.0
Trichlorotrifluoroethane	24.04	2.5
Dichlorobenzene	11.8	1.2
Trichlorofluoromethane	9.072	0.9
F003/Xylene	489.9	40.7
Methanol	317.5	26.3
Acetone	86.2	7.2
Methyl isobutyl ketone	78.0	6.5
Ethyl acetate	69.9	5.8
Ethanol	54.43	4.5
Ethyl ether	54.43	4.5
Butanol	45.36	3.8
Cyclohexanone	9.072	0.8
F004/Cresols	11.8	56.5
Nitrobenzene	9.072	43.5
F005/Toluene	317.5	51.5
Methyl ethyl ketone	202.3	32.8
Carbon disulfide	77.1	12.5
Isobutanol	18.6	3.0
Pyridine	0.907	0.2

[a] This table presents the annual usage of solvents in 1980.[43] The percent usage of each solvent with a waste code is estimated based on the 1980 data.

[b] Waste codes listed in 40 CFR 261.31, Hazardous wastes from non-specific sources.[44]

- Raw domestic wastewater is 0.07 percent solids.
- Digested domestic sludge is 10 percent solids.
- Vacuum-filtered sludge is 20 to 30 percent solids.

These principles were used, along with data from a RCRA land disposal restrictions background document,[46] which show that as much as 20 percent of the F codes in aqueous liquid (3XX) form are solvents. The same document was used to determine waste compositions for waste forms 4XX (organic liquid) and 5XX (organic sludge/solid). This document contains generic WET Model streams and their compositions for each of the three waste forms.

Table D-8 provides the default compositions developed for waste streams F001 to F005. In Table D-8, the waste stream constituent "water" may potentially contain oil.

Default compositions for all P and U code waste streams are designated 90-percent pure with 10 percent water when present in the natural physical/chemical form of the P and U chemical. A 90-percent purity is assumed given the nature of the regulatory listing, i.e., any commercial chemical product, manufacturing chemical intermediate, off-specification product, or intermediate (40 CFR 261.33). This manner of listing implies how close to purity the waste chemical is.[49]

D.2.2.11 Organic Concentration Limits. During the development of the WCDB, it was found that respondents to the Westat Survey often listed RCRA waste codes as aqueous liquids and sludges when the codes themselves were described in 40 CFR 261 as organic by nature, e.g., F001--spent halogenated solvents and organic K, P, and U waste codes. These occurrences of aqueous listings indicated that the concentrated organic compositions commonly found in the WCDB were not representative of the waste code in a dilute aqueous form and could cause an overestimation of emissions. Also, in reviewing ISDB data for D waste codes, it was noted that the organic content of aqueous liquids and sludges was related to the type of management process (e.g., total organic concentrations for wastewaters managed in uncovered tanks and impoundments were typically lower than those managed in enclosed units such as underground injection wells). These issues led to the derivation of organic concentration limits for those wastes described above. These limits are presented in Table D-9.

TABLE D-8. DEFAULT STREAM COMPOSITIONS FOR WASTE CODES F001 TO F005[a]

Waste code[b]	Waste form[c]	Composition, % constituent
F001	1XX	15.00% Trichloroethylene 60.00% Water 25.00% Solids
	2XX	18.00% Trichloroethylene 72.00% Water 10.00% Solids
	3XX	20.00% Trichloroethylene 80.00% Water
	4XX	60.00% Trichloroethylene 40.00% Water
	5XX	20.00% Trichloroethylene 80.00% Solids
	6XX	NA
F002	1XX	60.00% Water 25.00% Solids 3.99% Tetrachloroethylene 3.33% Methylene chloride 2.94% Trichloroethylene 2.84% Trichloroethane 1.20% Chlorobenzene 0.38% Trichlorotrifluoroethane 0.18% Dichlorobenzene 0.14% Trichlorofluoromethane
	2XX	72.00% Water 10.00% Solids 4.79% Tetrachloroethylene 4.00% Methylene chloride 3.53% Trichloroethylene 3.40% Trichloroethane 1.44% Chlorobenzene 0.45% Trichlorotrifluoroethane 0.22% Dichlorobenzene 0.16% Trichlorofluoromethane

See notes at end of table. (continued)

TABLE D-8 (continued)

Waste code[b]	Waste form[c]	Composition, % constituent
F002 (con.)		
	3XX	80.00% Water
		5.32% Tetrachloroethylene
		4.44% Methylene chloride
		3.92% Trichloroethylene
		3.78% Trichloroethane
		1.60% Chlorobenzene
		0.50% Trichlorotrifluoromethane
		0.24% Dichlorobenzene
		0.18% Trichlorofluoromethane
	4XX	40.00% Water
		16.00% Tetrachloroethylene
		13.30% Methylene chloride
		11.80% Trichloroethylene
		11.30% Trichloroethane
		4.80% Chlorobenzene
		1.50% Trichlorotrifluoromethane
		0.72% Dichlorobenzene
		0.54% Trichlorofluoromethane
	5XX	80.00% Solids
		5.32% Tetrachloroethylene
		4.44% Methylene chloride
		3.92% Trichloroethylene
		3.78% Trichloroethane
		1.60% Chlorobenzene
		0.50% Trichlorotrifluoromethane
		0.24% Dichlorobenzene
		0.18% Trichlorofluoromethane
	6XX	NA
F003	1XX	60.00% Water
		25.00% Solids
		6.10% Xylene
		3.94% Methanol
		1.08% Acetone
		0.98% Methyl isobutyl ketone
		0.87% Ethyl acetate
		0.68% Ethyl benzene
		0.68% Ethyl ether
		0.57% Butanol
		0.12% Cyclohexanone

See notes at end of table.

(continued)

TABLE D-8 (continued)

Waste code[b]	Waste form[c]	Composition, % constituent
F003 (con.)		
	2XX	72.00% Water
		10.00% Solids
		7.33% Xylene
		4.73% Methanol
		1.30% Acetone
		1.17% Methyl isobutyl ketone
		1.04% Ethyl acetate
		0.81% Ethyl benzene
		0.81% Ethyl ether
		0.68% Butanol
		0.14% Cyclohexanone
	3XX	80.00% Water
		8.14% Xylene
		5.26% Methanol
		1.44% Acetone
		1.30% Methyl isobutyl ketone
		1.16% Ethyl acetate
		0.90% Ethyl benzene
		0.90% Ethyl ether
		0.76% Butanol
		0.16% Cyclohexanone
	4XX	20.00% Water
		32.60% Xylene
		21.04% Methanol
		5.76% Acetone
		5.20% Methyl isobutyl ketone
		4.64% Ethyl acetate
		3.60% Ethyl benzene
		3.60% Ethyl ether
		3.04% Butanol
		0.64% Cyclohexanone
	5XX	80.00% Solids
		8.14% Xylene
		5.26% Methanol
		1.44% Acetone
		1.30% Methyl isobutyl ketone
		1.16% Ethyl acetate
		0.90% Ethyl benzene
		0.90% Ethyl ether
		0.76% Butanol
		0.16% Cyclohexanone
	6XX	NA

See notes at end of table.

(continued)

TABLE D-8 (continued)

Waste code[b]	Waste form[c]	Composition, % constituent
F004	1XX	60.00% Water 25.00% Solids 8.48% Cresols 6.52% Nitrobenzene
	2XX	72.00% Water 10.00% Solids 10.17% Cresols 7.83% Nitrobenzene
	3XX	80.00% Water 11.30% Cresols 8.70% Nitrobenzene
	4XX	20.00% Water 45.20% Cresols 34.80% Nitrobenzene
	5XX	80.00% Solids 11.30% Cresols 8.70% Nitrobenzene
	6XX	NA
F005	1XX	60.00% Water 25.00% Solids 7.72% Toluene 4.88% Methyl ethyl ketone 1.88% Carbon disulfide 0.45% Isobutanol 0.03% Pyridine
	2XX	72.00% Water 10.00% Solids 9.27% Toluene 5.90% Methyl ethyl ketone 2.25% Carbon disulfide 0.54% Isobutanol 0.04% Pyridine
	3XX	80.00% Water 10.30% Toluene 6.56% Methyl ethyl ketone 2.50% Carbon disulfide 0.60% Isobutanol 0.16% Pyridine

See notes at end of table. (continued)

TABLE D-8 (continued)

Waste code[b]	Waste form[c]	Composition, % constituent
F005 (con.)		
	4XX	20.00% Water 41.20% Toluene 26.20% Methyl ethyl ketone 10.00% Carbon disulfide 2.40% Isobutanol 0.16% Pyridine
	5XX	80.00% Solids 10.30% Toluene 6.56% Methyl ethyl ketone 2.50% Carbon disulfide 0.60% Isobutanol 0.16% Pyridine
	6XX	NA

NA = Not applicable.

[a] This table presents default waste stream compositions derived from WET model waste stream data[47] for wastewaters containing solvents and for organic liquids containing solvents. These defaults are used by the Source Assessment Model when Standard Industrial Classification code/waste code/waste form combinations are not found elsewhere in the Waste Characterizaton Data Base.

[b] Waste codes listed in 40 CFR 261.31, Hazardous wastes from non-specific sources.[48]

[c] Physical/chemical waste forms are coded as follows:

1XX = Inorganic solid
2XX = Aqueous sludge
3XX = Aqueous liquid
4XX = Organic liquid
5XX = Organic sludge
6XX = Miscellaneous.

TABLE D-9. CONCENTRATION LIMITS ASSUMED IN SOURCE ASSESSMENT MODEL (SAM) FOR ORGANIC CONCENTRATIONS IN WASTEWATERS AND AQUEOUS SLUDGES[a]

	Organic concentration limit, %	
Waste code[b]	Wastewaters (waste form 3XX)	Aqueous sludges (waste form 2XX)
P _ _ _[c]	1%	1%
U _ _ _[c]	1%	1%
F001-F005	1%[d]	1%[c]
K _ _ _[c,e]	1%	1%
D001[c,f]	5%	5%
D002[f]	0.4%[g]	0.4%[c]
D003[f]	6%[c]	6%[g]
D004 and greater[c,f]	0.1%	0.1%

[a] This table shows the maximum concentration the SAM assumes for organics when estimating emissions from wastewaters and aqueous sludges. These assumptions are conditional as described in the footnotes below and in Section D.2.2.11.

[b] Waste codes listed in 40 CFR 261, Identification and Listing of Hazardous Waste, Subpart C, Characteristics of Hazardous Waste, and Subpart D, Lists of Hazardous Wastes.[50]

[c] Source: Best engineering judgment based on review of waste code descriptions. (Nonconfidential Industry Studies Data Base data are inadequate or do not exist.)

[d] Source: Land disposal restrictions regulatory impact analysis.[51]

[e] Concentration limits apply only to K waste codes that are organic by nature of their listing, e.g, organic still bottoms and organic liquids. These limits do not apply to K waste codes that are listed as inorganic solids or aqueous sludges or liquids in 40 CFR 261.32.[52]

[f] Concentration limits apply only to aqueous liquids and sludges of RCRA D waste codes managed in open units, i.e., storage, treatment, and disposal impoundments and open treatment tanks.

[g] Source: EPA data analysis of nonconfidential Industry Studies Data Base data.

Sections D.2.2.11.1 through D.2.2.11.4 discuss these limits on organic content.

D.2.2.11.1 F001 to F005 (spent solvent). During the development of the proposed land disposal restriction rules for solvents and dioxins,[53] EPA/OSW analyzed waste composition data from a number of sources including the ISDB. The results of this analysis showed a median solvent concentration in wastewater (an aqueous liquid) of 0.05 percent and a mean of 0.3 percent.

The 1981 Westat Survey[54] identified greater than 99 percent of the solvent waste treated in surface impoundments as a wastewater form of the solvent. The land disposal restriction Regulatory Impact Analysis did not provide a typical waste composition of solvents in these wastewaters; however, it did state that solvent constituent concentrations in F001 to F005 wastes may be "as little as one percent or less (if present at all)."[55] For these reasons, a limit of 1 percent was set on solvents found in wastewater. The 1-percent limit was also assigned to aqueous sludges.

D.2.2.11.2 Organic P, U, and K wastes. It was also decided to assign 1-percent organic concentration limits to aqueous liquids and sludges of organic P, U, and K wastes because of the decisionmaking used for solvents F001 to F005. Given that these P, U, and concentrated organic K wastes are just as concentrated as solvent wastes (based on their normal listing as organic liquids or sludges), their dilution to 1 percent or less in wastewater or aqueous sludges should be comparable to the solvents in F001 to F005. Many of these organics also may be insoluble in water and are decanted from the wastewater before it enters the open management unit. Therefore, a 1-percent organic concentration limit was assigned to these waste codes when they occur as wastewaters or aqueous sludges.

D.2.2.11.3 D001. This limit reflects the minimum concentration of an ignitible organic in water that causes the water to exhibit an ignitible characteristic. Based on engineering judgment, the organic concentration limit designated for D001 is 5 percent. For example, an ignitible organic liquid (about 100 percent organic) has a heat value of about 30,000 J/g; an aqueous liquid containing 10 percent ignitible organic may have a heat value of 3,000 J/g and thus still be burnable; however, an aqueous liquid with 1 percent ignitible organic will not be ignitible because the heat value is 300 J/g. As another example, ignitible methanol can have a concentration in water between 2 and 10 percent and the water remains ignitible. Less than 1 percent would not be ignitible. This range of 1 to 10 percent was used to arrive at an average minimum concentration of an ignitible organic in wastewater that yields an ignitible aqueous liquid, i.e., 5 percent.

D.2.2.11.4 D002, D003, and D004 to D017 (DXXX). Concentration limits were established for these waste codes using the ISDB. The ISDB was searched to identify D002, D003, and D004 to D017 waste codes that were either aqueous liquids (wastewaters) or sludges and were managed in storage surface impoundments, onsite wastewater impoundments, or onsite wastewater tanks. Each of these management devices was considered open to the atmosphere. Once these waste compositions were found, a weighted average was taken for each waste code managed in these open units based on quantity managed for each waste code/waste form combination. These weighted averages serve as organic concentration limits for the open waste management units.

D.2.3 Chemical Properties

D.2.3.1 Introduction. Emission estimation on a constituent basis for each of the more than 4,000 TSDF waste constituents identified in the data bases was not possible because of a lack of constituent-specific data and because of the large number of chemicals involved. Therefore, to provide the emission models with relevant physical, chemical, and biological properties that influence emissions and still maintain a workable and efficient method of estimating emissions, waste constituent categorization was required. Waste constituent categorization allows the SAM to make emission estimates for all constituents by making emission estimates for a set of chemicals (surrogates) that represent the universe of organic chemicals that occur in hazardous waste streams.

D.2.3.2 Waste Characteristics Affecting Emissions. In the development of air emission models for hazardous waste TSDF, the means by which organic compounds escape to the environment from TSDF was determined. It was found that the fate of organic compounds in surface impoundments, land treatment facilities, landfills, wastepiles, or wastewater treatment (WWT) plant effluents can be affected by a variety of pathway mechanisms, including volatilization, biological decomposition, adsorption, photochemical reaction, and hydrolysis. The relative importance of these pathways for TSDF waste management processes was evaluated based on theoretical considerations, data appearing in the literature, and engineering judgment. The predominant removal pathways for organic compounds at TSDF sites were found to be volatilization and biodegradation. For this reason, the emission models used for TSDF in the air emission models report[56] are all based on volatilization and/or biodegradation as the principal pathways included in the models. Volatilization occurs when molecules of a liquid or solid substance escape to an adjacent gas phase. Biodegradation takes place when microbes break down organic compounds for metabolic processes.

Several waste characteristics contribute to the potential for a waste constituent to be volatilized or released to the atmosphere. Major factors include the types and number of hazardous constituents present, the concentrations of these constituents in the waste, and the chemical and physical characteristics of the waste and its constituents. In conjunction with the type of management unit, the physical and chemical properties of the waste constituents will affect whether there will be pollutants released and what form the release will take (i.e., vapor, particulate, or particulate-associated). Important physical/chemical factors to consider when assessing the volatilization of a waste constituent include:

- Water solubility. The solubility in water indicates the maximum concentration at which a constituent can dissolve in water at a given temperature. This value can be used to estimate the distribution of a constituent between the dissolved aqueous phase in the unit and the undissolved solid or immiscible liquid phase. Considered in combination with the constituent's vapor pressure, solubility can provide a relative assessment of the potential for volatilization of a constituent from an aqueous environment.

- Vapor pressure. This property is a measure of the pressure of vapor in equilibrium with a pure liquid. It is best used in a relative sense as a broad indicator of volatility; constituents with high vapor pressures are more likely to be released than are those with low vapor pressures, depending on other factors such as relative solubility and concentration (e.g., at high concentrations, release can occur even though a constituent's vapor pressure is relatively low).

- Octanol/water partition coefficient. The octanol/water partition coefficient indicates the tendency of an organic constituent to absorb to organic components of soil or waste matrices. Constituents with high octanol/water partition coefficients tend to adsorb readily to organic carbon, rather than volatilize to the atmosphere. This is particularly important in landfills and land treatment units, where high organic carbon content in soils or cover material can significantly reduce the release potential of volatile constituents.

- Partial pressure. A partial pressure measures the pressure that each component of a mixture of liquid or solid substances will exert to enter the gaseous phase. The rate of volatilization of an organic chemical when either dissolved in water or present in a solid mixture is characterized by the partial pressure of that chemical. In general, the greater the partial pressure, the greater the potential for release. Partial pressure values are unique for any given chemical in any given mixture and may be difficult to obtain.

- Henry's law constant. Henry's law constant is the ratio of the vapor pressure of a constituent to its aqueous solubility (at equilibrium). This constant can be used to assess the relative ease with which the compound may vaporize from the aqueous phase. It is applicable for low concentration (i.e., less than 10 percent) wastes in aqueous solution and will be most useful when the unit being assessed is a surface impoundment or tank containing dilute wastewaters. The potential for significant vaporization increases as the value for Henry's law constant increases.

- Raoult's law. Raoult's law accurately predicts the behavior of most concentrated mixtures of water and organic solvents (i.e., solutions over 10 percent solute). According to Raoult's law, the rate of volatilization of each chemical in a mixture is proportional to the product of its concentration in the mixture and its vapor pressure. Therefore, Raoult's law can also be used to characterize volatilization potential.

The air emission models report provides the most up-to-date guidance on assessing the volatilization of waste constituents and contains a compilation of chemical/physical properties for several hundred constituents.

Through review of available literature relating to TSDF emission modeling, it was judged that volatility, which is an index of emission potential, can best be characterized across the entire waste population by either vapor pressure or Henry's law constant depending on the waste matrix. One case accounts for chemical compounds in situations in which Henry's law governs mass transfer from the waste (i.e., low organic concentration in aqueous solution), and the other case accounts for chemical compounds in those situations in which mass transfer is governed by vapor pressure (i.e., concentrated mixtures of organics).

Three chemical and biological properties are therefore critical in estimating TSDF emissions: vapor pressure, Henry's law constant, and biodegradation rate. These were selected as the basis for designating waste constituent and surrogate categories.

D.2.3.3 Waste and Surrogate Categorization.

D.2.3.3.1 Waste properties--physical and chemical. Efforts to categorize the universe of chemical compounds found at hazardous waste sites were based on information contained in the CHEMDAT3 data base.[57] The 60 chemicals and their properties available from this data base, originally used in predicting organic emissions, formed the basis for both waste constituent categorization and surrogate properties selection. Table D-10 provides the primary data for the 60 chemicals used in developing surrogate categories and properties.

D.2.3.3.1.1 Vapor pressure categories. In 1985, EPA published a comprehensive catalog of physical and chemical properties of hazardous waste in relation to potential air emissions of wastes from TSDF. The waste volatility categorization scheme presented in the document[59] divided vapor pressures into three useful categories: high (>1.33 kilopascals [kPa]), moderate (1.33×10^{-4} to 1.33 kPa), and low ($<1.33 \times 10^{-4}$ kPa). Sensitivity analysis on the impact of vapor pressure on emissions pointed out that organics that are gases at standard temperature and pressure skewed the average emission rates for the high vapor pressure chemicals. Emission estimates for high vapor pressure chemicals were dominated by the gases; an average figure would overestimate emissions for most high vapor pressure chemicals because gases are relatively few in number among the high category chemicals. Therefore, compounds with vapor pressures greater than 101.06 kPa were segregated into their own "very high" category, creating four categories of vapor pressure chemicals. Vapor pressures for

TABLE D-10. DATA USED FOR WASTE CONSTITUENT CATEGORIZATION AND SURROGATE PROPERTY SELECTION IN THE SOURCE ASSESSMENT MODEL[a,b]

Compound name	Vapor pressure, kPa	Henry's law constant, 10^{-3} kPa·m^3/g mol	Biorate, mg VO/g/h	Biodegradability category	Surrogate category[c]	
					Vapor pressure	Henry's law constant
Acetaldehyde	122	9.6	82.4	High	10	4
Methyl ethyl ketone	13.3	4.4	73.8	High	1	4
Toluene	3.99	675	73.5	High	1	1
Acrylonitrile	15.2	8.9	44.30	High	1	4
Pyridine	2.02	2.4	35.03	High	1	4
Phenol	0.045	0.0459	33.6	High	4	7
Butanol-1	0.864	0.9	32.4	High	4	7
Dichloroethane (1,2)	10.6	6.4	0.302	Low	3	3
Formaldehyde	465	5.8	20.91	High	10	4
Cresol (-m)	0.01	0.3	23.2	High	4	7
Cresol (-p)	0.015	0.3	23.2	High	4	7
Cresols	0.019	0.3	23.2	High	4	7
Cresol (-o)	0.032	0.3	22.8	High	4	7
Methylene chloride	58.2	322	22.00	High	1	1
Isobutyl alcohol	1.33	0.2	21.2	High	4	7
Methyl acetate	31.2	NA	19.9	High	1	1
Benzene	12.7	556	19.00	High	1	1
Benzyl chloride	0.0093	52.7	17.8	High	4	4
Ethyl acetate	11.3	12.9	17.6	High	1	4
Cresylic acid	0.04	0.2	15.00	High	4	7

See notes at end of table.

(continued)

TABLE D-10 (continued)

Compound name	Vapor pressure, kPa	Henry's law constant, 10^{-3} kPa*m^3/g mol	Biorate, mg VO/g/h	Biodegradability category	Surrogate category[c]	
					Vapor pressure	Henry's law constant
Acetone	35.4	2.5	14.6	High	1	4
Methanol	15.2	0.3	12.00	High	1	7
Cyclohexanone	0.64	0.4	11.5	High	4	7
Dichlorobenzene (1,2) (-o)	0.2	198	10.00	High	4	1
Acrolein	32.5	5.7	7.60	Moderate	2	5
Nitrobenzene	0.04	1.3	0.302	Low	6	6
Maleic anhydride	1.33×10^{-5}	0.004	4.08	Moderate	8	8
Chloroform	27.7	3.42	0.302	Low	3	3
Chlorobenzene	1.67	397	1.46	Moderate	2	2
Ethylether	89.1	68.7	0.77	Low	3	6
Methyl isobutyl ketone	0.997	4.4	0.74	Low	6	6
Allyl alcohol	3.098	NA	NA	Moderate	2	8
Carbon disulfide	48.7	1,212	NA	Moderate	2	2
Carbon tetrachloride	15.03	3,030	NA	Low	3	3
Chloroprene	38.3	NA	NA	Low	3	NA
Cumene (isopropylbenzene)	0.612	1,480	NA	Moderate	5	2
Dichlorobenzene (1,4) (-p)	0.16	162	NA	Moderate	5	2
Dimethyl nitrosamine	NA	NA	NA	Moderate	NA	NA
Dioxin	NA	NA	NA	Low	NA	NA
Epichlorohydrin	2.26	3.3	NA	Low	3	6
Ethylbenzene	1.33	650	NA	High	4	1

See notes at end of table.

(continued)

TABLE D-10 (continued)

Compound name	Vapor pressure, kPa	Henry's law constant, 10^{-3} kPa*m^3/g mol	Biorate, mg VO/g/h	Biodegradability category	Surrogate category[c]	
					Vapor pressure	Henry's law constant
Ethylene oxide	166	3.7	NA	High	10	4
Freons	NA	NA	NA	Low	NA	NA
Hexachlorobutadiene	0.02	2,590	NA	Low	6	3
Hexachlorocyclopentadiene	0.0106	1,620	NA	Low	6	3
Naphthalene	0.031	119	NA	Moderate	5	2
Nitrosomorpholine	NA	NA	NA	Low	NA	NA
Phosgene	185	17,300	NA	Low	12	3
Phthalic anhydride	0.0002	0.1	NA	High	4	7
Polychlorinated biphenyls	NA	20.2	NA	Low	NA	NA
Proplyene oxide	59.2	19.4	NA	High	1	4
Tetrachloroethane (1,1,2,2)	0.664	38.4	NA	Low	6	6
Tetrachloroethylene	2.53	NA	NA	Low	3	3
Trichloro (1,1,2) trifluoroethane		119	NA	Low	3	3
Trichloroethane (1,1,1)	16.4	8,001	NA	Low	3	3
Trichloroethylene	9.97	919	NA	Low	3	3
Trichlorofluoromethane	106.0	5,890	NA	Low	12	3
Vinyl chloride	354	8,690	NA	Low	12	3
Vinylidene chloride	78.6	19,200	NA	Low	3	3
Xylene (-o)	0.931	610	NA	High	4	1

NA = Not available.

VO = Volatile organics.

[a] This table provides the primary data for 60 chemicals used in developing surrogate categories to be used in the Source Assessment Model.

[b] Source of data: Research Triangle Institute. CHEMDAT3 Database for Predicting VO Emissions from Hazardous Waste Facilities. Developed for Office of Research and Development, U.S. Environmental Protection Agency. Cincinnati, OH. 1986.[68]

[c] Refers to surrogate categories defined in Table D-11.

the 60 reference chemicals were obtained from or estimated using methods commonly found in engineering and environmental science handbooks.[60,61,62]

D.2.3.3.1.2 Henry's law categories. The Henry's law constant is a measure of the diffusion of organics into air relative to diffusion through liquids. Henry's law constants are generated using vapor pressure, molecular weight, and solubility. Henry's law is used in predicting emissions for aqueous systems. An analysis to determine the effects of Henry's law constant on the organic fraction emitted to air, using the TSDF air emission models, was used in establishing Henry's law constant categories. Results showed discernible patterns in the relationship between the organic fraction emitted and Henry's law constant. The fraction emitted begins to drop sharply for low values of Henry's law constant ($<10^{-3}$ kPa m^3/g mol) as the mass transfer becomes affected by both gas and liquid phase control. When Henry's law constant is greater than 10^{-1} kPa m^3/g mol, rapid volatilization will generally occur. A number of citations found in the literature support the Henry's law constant volatilization categories selected.[63,64] Henry's law constants were grouped as follows:

- High $>10^{-1}$, kPa m^3/g mol
- Moderate 10^{-1} to 10^{-3}, kPa m^3/g mol
- Low $<10^{-3}$, kPa m^3/g mol.

D.2.3.3.1.3 Biodegradation categories. Quantitative biodegradation values for the 60 chemicals were grouped as follows: high = >10 mg organics/g of biomass/h, moderate = 1 to 10 mg organics/g/h, and low = <1 mg organics/g/h. This classification follows the biorate designation provided with the data base on the 60 chemicals.[65] In some cases, the biodegradation rate was inconsistent with values reported elsewhere for measures such as BOD_5, soil half-life, and ground-water degradation. It is understood that biodegradability is variable and depends on the matrix, the concentration of organics and microorganisms, and temperature. However, to provide an "average" biorate that represents all TSDF management processes, biodegradation rates provided for many of the 60 chemicals were compared to other measures of biodegradation and adjusted if appropriate.

D.2.3.3.2 Surrogate categories. With 4 categories of vapor pressure, 3 of Henry's law constant, and 3 of biodegradation, a chemical could fall into one of 12 possible categories of vapor pressure and biodegradation (4 x 3) and into one of 9 categories of Henry's law constant and biodegradation. These two surrogate groups (i.e., vapor pressure surrogates and Henry's law surrogates) represent two volatility situations: where vapor pressure is the mass transfer driving force in one case and where Henry's law constant best represents or governs mass transfer in the other. Table D-11 provides the definition of surrogate categories.

D.2.3.3.3 Surrogate properties--physical and chemical. The chemical and biological properties selected to represent each surrogate are, generally, averages for groupings of the 60 chemicals categorized by vapor pressure/biodegradation and Henry's law constant/biodegradation. It should be noted that not all of the possible categories of vapor pressure/biodegradation and Henry's law constant/biodegradation were unique. The low vapor pressure categories were judged to be relatively equivalent; therefore, the low vapor pressure/moderate biorate (LVMB) properties were used for all low vapor pressure compounds. The low Henry's law constant/low biorate (LHLB) category was judged to be very similar to the low Henry's law constant/moderate biorate (LHMB) category. The high vapor pressure/moderate biorate (HVMB) and the high vapor pressure/low biorate (HVLB) were also found to be similar in predicting emissions. Property values for all surrogate categories are therefore not presented. Tables D-12 and D-13 summarize the surrogate properties for the vapor pressure and the Henry's law constant groupings, respectively.[66]

Emissions for waste management processes that are modeled using vapor pressure draw their surrogate properties from vapor pressure and biodegradation group averages. Similarly, processes best modeled by Henry's law constant draw surrogate properties from the groupings of Henry's law constant and biodegradation. This is because the SAM, as designed, handles only a single set of emission factors for each waste management unit; for example, only Henry's law constant surrogates are used to calculate emissions for surface impoundment operations because emissions from surface impoundment wastes are predominantly Henry's law controlled and because

TABLE D-11. DEFINITION OF WASTE CONSTITUENT CATEGORIES (SURROGATES) APPLIED IN THE SOURCE ASSESSMENT MODEL[a]

	Surrogate category	Constituent properties		
		VP[b]	HLC[c]	Bio[d]
Vapor Pressure Surrogates	1	H	NA	H
	2	H	NA	M
	3	H	NA	L
	4	M	NA	H
	5	M	NA	M
	6	M	NA	L
	7	L	NA	H
	8	L	NA	M
	9	L	NA	L
	10	VH	NA	H
	11	VH	NA	M
	12	VH	NA	L
Henry's Law Constant Surrogates	1	NA	H	H
	2	NA	H	M
	3	NA	H	L
	4	NA	M	H
	5	NA	M	M
	6	NA	M	L
	7	NA	L	H
	8	NA	L	M
	9	NA	L	L

NA = Not applicable.

[a] This table describes the volatility and biodegradation properties of each waste constituent (surrogate) category developed for use in the Source Assessment Model.

[b] VP = Vapor pressure categories:

VH = Very high (>101.06 kPa).
H = High (1.33-101.06 kPa).
M = Moderate (1.33×10^{-4}-1.33 kPa).
L = Low ($<1.33 \times 10^{-4}$ kPa).

[c] HLC = Henry's law constants.

H = High ($>10^{-1}$ kPa m^3/g mol).
M = Moderate (10^{-1}-10^{-3} kPa m^3/g mol).
L = Low ($<10^{-3}$ kPa m^3/g mol).

[d] Bio = Biodegradation rates:

H = High (>10 mg VO/g biomass/h).
M = Moderate (1-10 mg VO/g biomass/h).
L = Low (<1 mg VO/g biomass/h).

TABLE D-12. PROPERTIES FOR VAPOR PRESSURE AND BIODEGRADATION GROUPINGS[a] AT 25 °C OF WASTE CONSTITUENT CATEGORIES (SURROGATES) SHOWN IN TABLE D-11

Surrogate category[b]	M.W.	Vapor pressure at 25 °C kPa (10^{-3})	Diffusivity in water, cm^2/s (10^{-6})	Diffusivity in air, cm^2/s (10^{-3})	Biorate, mg VO/g/h
HVHB (1)	73.6	27.4	10.6	98.9	34.30
HVMB (2)	72.5	24.2	10.7	134	5.97
HVLB (3)	117.0	34	9.63	89.9	0.30
MVHB (4)	111.0	0.346	9.02	76.8	22.60
MVMB (5)	132.0	0.266	7.50	64.3	3.02
MVLB (6)	185.0	0.386	7.32	66.9	0.39
LVMB (8)	98.0	1.33×10^{-5}	11.1	95	4.08
VHVHB (10)	39.3	251	14.6	101	47.50
VHVLB (12)	80.7	270	11.8	107	0.30

M.W. = Molecular weight.
VO = Volatile organics.
HVHB = High vapor pressure, high biorate.
HVMB = High vapor pressure, moderate biorate.
HVLB = High vapor pressure, low biorate.
MVHB = Moderate vapor pressure, high biorate.
MVMB = Moderate vapor pressure, moderate biorate.
MVLB = Moderate vapor pressure, low biorate.
LVMB = Low vapor pressure, moderate biorate.
VHVHB = Very high vapor pressure, high biorate.
VHVLB = Very high vapor pressure, low biorate.

[a] Properties presented in this table are averages for compounds found within a given category. A detailed discussion on the development of this table can be found in a memorandum to the docket.[67]

[b] Not all of the 12 possible categories were unique. The low vapor pressure categories (LVHB, LVMB, and LVLB) were judged to be relatively equivalent. Therefore, the LVMB group properties were used for all low vapor pressure compounds. The moderate and low biorate categories for the very high vapor pressure group were also shown to result in similar emissions; therefore, the VHVLB group properties were used for both categories.

TABLE D-13. PROPERTIES FOR HENRY'S LAW CONSTANT AND BIODEGRADATION GROUPINGS OF WASTE CONSTITUENT CATEGORIES (SURROGATES) SHOWN IN TABLE D-11[a]

Surrogate category	M.W.	Diff. water, cm^2/s (10^{-6})	Diff. air, cm^2/s (10^{-3})	Biorate, mg VO/g/h	X_{VOC} (10^{-3})	Temperature adjustment equation[b]	H-law const. 298 K[c] (10^{-6})
MHLB (6)	112.0	8.60	78.4	0.39	3.27	$H = e[(-4079.12/T) + 17.1720]/990$	22.5
HHLB (3)	144.0	9.39	87.6	0.302	2.54	$H = e[(-2275.36/T) + 15.0418]/990$	3,030
LHMB (8)	78.4	11.3	100	3.55	4.66	$H = e[(-11502.27/T) + 23.14]/.0099$	0.100
MHMB (5)	57.0	11.0	115	11.2	6.40	$H = e[(-4090.15/T) + 15.13143]/990$	41.2
HHMB (2)	117.0	8.24	74	2.71	3.13	$H = e[(-5402.87/T) + 23.10247]/990$	1,190
LHHB (7)	97.3	9.64	82.7	23.2	3.76	$H = e[(-11502.27/T) + 23.14]/.0099$	0.100
MHHB (4)	69.9	11.6	95.6	40.1	5.23	$H = e[(-3258.36/T) + 12.84471]/990$	60.7
HHHB (1)	98.4	9.40	87.3	29.2	3.72	$H = e[(-3100.14/T) + 16.95871]/990$	6,430

X = Mole fraction of volatile organic compounds (VOC).
VO = Volatile organics.
Diff. = Diffusivity.
M.W. = Molecular weight.
MHLB = Moderate Henry's law constant, low biorate.
HHLB = High Henry's law constant, low biorate.
LHMB = Low Henry's law constant, moderate biorate.
MHMB = Moderate Henry's law constant, moderate biorate.
HHMB = High Henry's law constant, moderate biorate.
LHHB = Low Henry's law constant, high biorate.
MHHB = Moderate Henry's law constant, high biorate.
HHHB = High Henry's law constant, high biorate.

Note: (1) The low Henry's law constant--low biorate category is not provided because it was judged to be very similar to the LHMB category in predicting emissions.
(2) The weight fraction of the surrogate (g surrogate/g waste), WI/W, was assumed to be 2.00×10^{-2} for all surrogate categories.

[a] This table presents average properties for compounds found in a given surrogate category. A detailed discussion on the development of this table can be found in a memorandum to the docket.[68]

[b] Henry's law constant units are $Kpa \cdot m^3/g$ mol. The equation predicts Henry's law constant for a range of temperatures for each category.

[c] Henry's law constants at 25 °C (298 K) are those used in emission models; see Appendix C.

dilute aqueous wastes are typically stored there. In the case of Henry's law constants, surrogate values were not based on group averages. For the surrogate's Henry's law constant, a single constituent was selected to represent the surrogate group; all other surrogate properties are averages of the group of constituents that fall into the particular surrogate category. This approach was selected in order to generate the temperature-dependent Henry's law constant equations needed for each surrogate category.

D.2.3.4 Assigning Surrogates. The TSDF Waste Characterization Data Base (see Section D.2.2) data sources often provided only generic descriptions of waste constituents, e.g., "amino alkane." Therefore, the first requirement in assigning a surrogate to the more than 4,000 constituent chemicals found in the WCDB was the assignment of specific common chemicals to represent the generic compounds. Next, all specific chemicals were assigned physical, chemical, and biodegradation values. Vapor pressures and Henry's law constants were estimated for 25 °C, if possible. Vapor pressure values were not available for a large fraction of the chemicals. Vapor pressure assignments were completed by relating molecular structure and molecular weight to similar chemicals with known vapor pressures. Specific solubility values, used to estimate Henry's law constants, were assigned as follows when qualitative descriptions were found in the literature:[69,70] insoluble--2 mg/L, practically insoluble--10 mg/L, slightly soluble--100 mg/L, soluble--2,000 mg/L, very soluble--10,000 mg/L, and miscible--100,000 mg/L. If no information was found in the references, solubility values were estimated based on molecular structure. The molecular weight of chemicals was readily available or determinable, although there was some judgment required in assigning molecular weight for polymers. Biodegradation assignments were based on quantitative measures, although largely unavailable, or on a comparison of molecular structure with chemicals well characterized by biodegradation.[71] The approximate breakdown of biodegradation information is shown in Table D-14.

The biorate values used for predicting emissions were based on the biodegradation rates for the "high" class of 60 chemicals. The average biodegradation for the high category is approximately 30 mg VO/g biomass/h.

TABLE D-14. CLASSIFICATION OF BIODEGRADATION DATA[a]

	Classification		
Parameter	High	Moderate	Low
BOD_5	>1.0	1.0 to 0.25	<0.25
Soil half-life	<3 days	3 days to 30 days	>30 days

BOD_5 = 5-day biochemical oxygen demand.

[a] This table provides classification of biodegradation data so that waste constituents may be categorized for the Source Assessment Model based on biodegradability.

A value of 1/10th the average of the "high" biorates was applied for those compounds judged to display "moderate" degradation, and a value equal to 1/100th of the average of the "high" biorates was applied for those compounds judged to display "low" biodegradation. The low and moderate biodegradation values (1/100 and 1/10 of "high," respectively) were consistent with group averages for the 60 chemicals.

Once the complement of properties for all chemicals was completed, then all chemicals were grouped into appropriate surrogate categories based on their vapor pressure, Henry's law constant, and biodegradation values.

D.2.4 Emission Factors

D.2.4.1 Introduction. A major objective of the SAM was to develop nationwide estimates of organic compound emissions to the atmosphere for the range of organic chemicals found at hazardous waste sites. Therefore, for each of the TSDF chemical surrogate categories selected to represent the organic chemicals that occur in hazardous waste streams, the emission models discussed in Appendix C of Reference 5 and the air emission models report[72] were used to estimate organic losses to the atmosphere. Emissions were estimated for process losses and transfer and handling losses (i.e., spills, loading losses, and equipment leaks) for each type of TSDF management process. Loss of organics from the waste stream through biodegradation was also estimated for those management processes having associated biological activity.

An important point concerning the emission factors is that they are a function of chemical surrogate properties, air emission models, and TSDF model unit parameters. For each chemical constituent, the assigned surrogate's chemical, physical, and biological properties are used in determining the fraction of incoming organics that are emitted or biodegraded. Other input parameters to the emission models are provided by the TSDF model units discussed in Chapter 5. Once a surrogate is chosen, the TSDF model unit selected, and the emission model determined, values for emission factors can be estimated.

D.2.4.2 Emission Models. The emission factors used for estimating TSDF emissions in this document were calculated using the TSDF air emission models as presented in the March 1987 draft of the Hazardous Waste Treatment, Storage, and Disposal Facilities: Air Emission Models, Draft Report. Since that time, certain TSDF emission models have been revised and a new edition of the air emission models report was released (December 1987). The principal changes to the emission models involved refining the biodegradation component of the models to more accurately reflect biologically active systems handling low organic concentration waste streams. With regard to emission model outputs, the changes from the March 1987 draft to the December 1987 version affected, for the most part, only aerated surface impoundments and result in a minor increase in the fraction emitted for the chemical surrogates in the high biodegradation categories. For the other air emission models, such as the land treatment model, which were also revised to incorporate new biodegradation rate data, the changes did not result in appreciable differences in the emission estimates. Since the December 1987 report version was issued, new data on biodegradation rates have been obtained and comments were received.[73] Based on these data and comments, the biodegradation model for aerated wastewater treatment systems was further revised to incorporate Monod kinetics. Additional investigation and comments led to an evaluation of changes to the model units used for aerated tanks and impoundments and assumed surrogate concentrations. These changes improve the technical basis for the biodegradation model. However, the combined effect of these changes did not significantly affect the estimated nationwide emissions and other impacts presented in this document.[74] Therefore, the emission factors listed in this appendix remain based on the March 1987 draft of the air emission model report, the model unit definitions have not been changed, and the assumed surrogate concentrations have not been changed.

These models represent long-term steady-state emissions for land treatment, first-year emissions for landfills, and emissions consistent with residence times identified for the model units for wastepiles, surface impoundments, containers, and tanks. Inputs to the models are those that are determined to best predict average, long-term emission characteristics rather than short-term peak concentrations. Long-term emissions are judged to be more representative of actual TSDF emission patterns and best characterize those management process emissions that are potentially controlled. Long-term emission estimates (i.e., annual averages) are also required for impacts analysis; costs, cancer incidence, and ozone effects all are based on long-term emissions. Short-term emissions such as those resulting from application of waste to the soil surface in land treatment, as opposed to postapplication emissions, and therefore are not included in the emission estimates.

Input parameters differ for each emission model and include such variables as unit size, throughput, and retention time, all of which were selected to be as consistent and representative as possible across the management processes. A detailed breakdown of the model unit input parameters by management process is presented in Appendix C, Section C.2, of Reference 5.

D.2.4.3 Emission Factor Files. To determine TSDF emission factors for use in the SAM, information on process type, design characteristics, and operating parameters was necessary. Within each waste management process represented by a process code (e.g., S01, S02, T01, or T02), there are in most cases distinct process types. For example, treatment tanks (T01) can be quiescent or aerated, and quiescent tanks can be either covered or uncovered. Table D-15 presents the distribution of waste management process types used in the SAM to characterize the breakdown of waste management processes on a nationwide basis.

For each waste management process type within a process code, multiple model units (described in Appendix C of Reference 5) were developed to span the range of nationwide design characteristics and operating parameters (i.e., surface area, waste throughputs, detention time, etc.). Because these particular characteristics were generally not available for site-specific estimates, it was necessary to develop a "national average model unit" to represent each waste management process or process type. This was

TABLE D-15. NATIONWIDE DISTRIBUTION OF WASTE MANAGEMENT PROCESS TYPES USED IN THE SOURCE ASSESSMENT MODEL[a]

Process code	Process type	National distribution, %
Container storage (S01)	Drum storage	97
	Dumpsters	3
Tank storage (S02)	Covered storage	79
	Uncovered storage	21
Tank treatment (T01)	Quiescent covered treatment	30
	Quiescent uncovered treatment	20
	Aerated/agitated uncovered treatment	50
Surface impoundment treatment (T02)	Quiescent treatment	29
	Aerated/agitated treatment	71
Other treatment (T04)[b]	Quiescent covered treatment	100
Landfill disposal (D80)	Onsite active landfill	14
	Onsite closed landfill	55
	Offsite active landfill	6
	Offsite closed landfill	25
Land treatment (D81)	Surface application	93
	Subsurface application	7

[a] This table presents the estimated national distribution of waste management process types within a process code. Those process codes not listed are not subdivided within the process code.

[b] Other treatment is not subdivided, but is defined as a quiescent covered treatment tank for modeling purposes.

accomplished by generating a set of weighting factors for each TSDF waste management process or process type based on frequency distributions of quantity processed, unit size, or unit area that were presented in results of the Westat Survey. Each set of weighting factors (presented in Appendix C, Section C.2, of Reference 5) approximates a national distribution of the model units defined for a particular TSDF waste management process or process type.

An emission estimate was generated for each chemical surrogate category for each management process or process type. Process parameters and surrogate properties used to estimate emission factors are presented in Table D-16. Emission estimates generally were calculated on a mass-per-unit-time basis (i.e., grams per second) and scaled by the appropriate operating times to get emissions in megagrams per year. The emission values then were divided by the annual organic input quantity for the respective model unit in megagrams per year. The emission factors for each model unit, emissions per megagram of throughput, were then multiplied by the appropriate weighting factor, and those products were summed to get the weighted emission factor for each waste management process.

A set of weighted emission factors was generated for all surrogate classes and all the SAM management processes. In addition to emission factors for process-related emissions, emission factors were developed for transfer and handling related emissions. Also calculated were factors used to predict biodegradation quantities. These TSDF emission factors were developed to be general representations of emissions and biodegradation fractions for all waste types, waste concentrations, and waste forms as well as management process combinations and process unit sizes on a nationwide basis. As such, these emission factors were incorporated into the SAM program file that is used to generate the SAM nationwide emission estimates. A listing of the TSDF emission factor files is included in Table D-17. A separate block of numbers is presented for each management process with rows denoting surrogate category and columns denoting: (1) surrogates, (2) annual fraction of surrogate emitted to air as a process emission, (3) annual fraction biodegraded, (4) annual fraction emitted from handling and loading, (5) annual fraction emitted from spills, and (6) annual fraction emitted from equipment leaks.

TABLE D-16. HAZARDOUS WASTE MANAGEMENT PROCESS PARAMETERS AND WASTE CONSTITUENT PROPERTIES USED TO ESTIMATE EMISSION FACTORS FOR SOURCE ASSESSMENT MODEL[a]

Waste management process	Physical/chemical waste form	Surrogate group	Waste organic concentration
Covered tank storage (S02)	Organic liquid	Vapor pressure	Pure component
Uncovered tank storage (S02)	Aqueous liquid	Henry's law	1,000 ppm
Storage impoundments (S04)	Aqueous liquid	Henry's law	1,000 ppm
Covered quiescent treatment tanks (T01)	Aqueous liquid	Henry's law	1,000 ppm
Uncovered quiescent treatment tanks (T01)	Aqueous liquid	Henry's law	1,000 ppm
Uncovered aerated treatment tanks (T01)	Aqueous liquid	Henry's law	1,000 ppm
Quiescent treatment impoundments (T02)	Aqueous liquid	Henry's law	1,000 ppm
Aerated treatment impoundments (T02)	Aqueous liquid	Henry's law	1,000 ppm
Disposal impoundments (D83)	Aqueous liquid	Henry's law	1,000 ppm
Terminal loading impoundments and tanks (L01)	Aqueous liquid	Henry's law	1,000 ppm
Terminal loading storage tanks (L03)	Organic liquid	Vapor pressure	Pure component
Wastepiles (S03)	Organic/aqueous liquid (2 phase)	Vapor pressure	5%
Landfills (D80)	Organic/aqueous liquid (2 phase)	Vapor pressure	5%
Land treatment (D81)	Organic liquid	Vapor pressure	--

[a] This table presents, for those air emission models that require a waste concentration as input, necessary information to estimate organic emission factors from hazardous waste management facilities used in the Source Assessment Model.

TABLE D-17. EMISSION FACTOR FILES[a],[b]

	Weighted emission factors for container and drum storage (S01) using vapor pressure surrogates				Weighted emission factors for dumpster storage (S01) using vapor pressure surrogates				Weighted emission factors for covered tank storage (S02) using vapor pressure surrogates			
Surrogate	f(air)	f(sp)	f(load)	k(fug)	f(air)	f(sp)	f(load)	k(fug)	f(air)	f(sp)	f(load)[c]	k(fug)
1	--	0.0001	0.0013	0.0154	1.0000	0.0001	--	--	0.0012	0.0000	0.0000	0.003034
2	--	0.0001	0.0011	0.0154	1.0000	0.0001	--	--	0.0011	0.0000	0.0000	0.003034
3	--	0.0001	0.0018	0.0154	1.0000	0.0001	--	--	0.0017	0.0000	0.0000	0.003034
4	--	0.0001	0.0000	0.0154	0.4786	0.0001	--	--	0.0000	0.0000	0.0000	0.003034
5	--	0.0001	0.0000	0.0154	0.4014	0.0001	--	--	0.0000	0.0000	0.0000	0.003034
6	--	0.0001	0.0000	0.0154	0.8269	0.0001	--	--	0.0000	0.0000	0.0000	0.003034
7	--	0.0001	0.0000	0.0154	0.0000	0.0001	--	--	0.0000	0.0000	0.0000	0.003034
8	--	0.0001	0.0000	0.0154	0.0000	0.0001	--	--	0.0000	0.0000	0.0000	0.003034
9	--	0.0001	0.0000	0.0154	0.0000	0.0001	--	--	0.0000	0.0000	0.0000	0.003034
10	--	0.0001	0.0009	0.0154	1.0000	0.0001	--	--	0.0000	0.0000	0.0000	0.003034
11	--	0.0001	0.0140	0.0154	1.0000	0.0001	--	--	0.0000	0.0000	0.0000	0.003034
12	--	0.0001	0.0140	0.0154	1.0000	0.0001	--	--	0.0000	0.0000	0.0000	0.003034

See notes at end of table.

(continued)

TABLE D-17 (continued)

	Weighted emission factors for uncovered tank storage (S02) using Henry's law constant surrogates				Weighted emission factors for wastepiles (S03) using vapor pressure surrogates				Weighted emission factors for storage impoundments (S04) using Henry's law surrogates			
Surrogate	f(air)	f(sp)	f(load)	k(fug)	f(air)	f(sp)	f(load)	k(fug)	f(air)	f(sp)	f(load)	k(fug)
1	0.5510	0.0000	--	0.00304	0.0126	0.0000	--	--	0.7450	0.0000	--	0.00058
2	0.5480	0.0000	--	0.00304	0.0115	0.0000	--	--	0.7330	0.0000	--	0.00058
3	0.5510	0.0000	--	0.00304	0.0176	0.0000	--	--	0.7470	0.0000	--	0.00058
4	0.5450	0.0000	--	0.00304	0.0020	0.0000	--	--	0.7390	0.0000	--	0.00058
5	0.5410	0.0000	--	0.00304	0.0020	0.0000	--	--	0.7260	0.0000	--	0.00058
6	0.0400	0.0000	--	0.00304	0.0020	0.0000	--	--	0.0830	0.0000	--	0.00058
7	0.1100	0.0000	--	0.00304	0.0000	0.0000	--	--	0.0590	0.0000	--	0.00058
8	0.1000	0.0000	--	0.00304	0.0000	0.0000	--	--	0.0930	0.0000	--	0.00058
9	0.1000	0.0000	--	0.00304	0.0000	0.0000	--	--	0.0930	0.0000	--	0.00058
10					0.0275	0.0000	--	--				
11					0.0275	0.0000	--	--				
12					0.0275	0.0000	--	--				

See notes at end of table.

(continued)

TABLE D-17 (continued)

	Weighted emission factors for covered quiescent treatment tanks (T01) using Henry's law constant surrogates				Weighted emission factors for uncovered quiescent treatment tanks (T01) using Henry's law constant surrogates				Weighted emission factors for uncovered aerated treatment tanks (T01) using Henry's law constant surrogates				
Surrogate	f(air)	f(ep)	f(load)^c	k(fug)	f(air)	f(ep)	f(load)	k(fug)	f(air)	f(bio)	f(ep)	f(load)	k(fug)
1	0.0113	0.0000	0.0000	0.000066	0.1120	0.0000	--	0.000066	0.0700	0.0510	0.0000	--	0.000013
2	0.0022	0.0000	0.0000	0.000066	0.1060	0.0000	--	0.000066	0.7700	0.0110	0.0000	--	0.000013
3	0.0422	0.0000	0.0000	0.000066	0.1120	0.0000	--	0.000066	0.9650	0.0000	0.0000	--	0.000013
4	0.0002	0.0000	0.0000	0.000066	0.0090	0.0000	--	0.000066	0.1450	0.4200	0.0000	--	0.000013
5	0.0002	0.0000	0.0000	0.000066	0.0010	0.0000	--	0.000066	0.1010	0.0020	0.0000	--	0.000013
6	0.0001	0.0000	0.0000	0.000066	0.0040	0.0000	--	0.000066	0.0040	0.0000	0.0000	--	0.000013
7	0.0000	0.0000	0.0000	0.000066	0.0010	0.0000	--	0.000066	0.0085	0.3100	0.0000	--	0.000013
8	0.0000	0.0000	0.0000	0.000066	0.0030	0.0000	--	0.000066	0.0020	0.0550	0.0000	--	0.000013
9	0.0000	0.0000	0.0000	0.000066	0.0030	0.0000	--	0.000066	0.0020	0.0550	0.0000	--	0.000013

See notes at end of table.

(continued)

TABLE D-17 (continued)

Surrogate	Weighted emission factors for quiescent treatment impoundments (T02) using Henry's law constant surrogates				Weighted emission factors for aerated impoundments (T02) using Henry's law constant surrogates					Weighted emission factors for incineration (T03) using vapor pressure surrogates			
	f(air)	f(sp)	f(load)	h(fug)	f(air)	f(bio)	f(sp)	f(load)	h(fug)	f(air)	f(sp)	f(load)	h(fug)
1	0.5100	0.0000	--	0.000000	0.7120	0.0030	0.0000	--	0.000000	0.0001	0.0000	--	0.00045
2	0.5000	0.0000	--	0.000000	0.9700	0.0010	0.0000	--	0.000000	0.0001	0.0000	--	0.00045
3	0.5100	0.0000	--	0.000000	0.9000	0.0000	0.0000	--	0.000000	0.0001	0.0000	--	0.00045
4	0.5000	0.0000	--	0.000000	0.3200	0.7700	0.0000	--	0.000000	0.0001	0.0000	--	0.00045
5	0.4910	0.0000	--	0.000000	0.0330	0.0000	0.0000	--	0.000000	0.0001	0.0000	--	0.00045
6	0.4000	0.0000	--	0.000000	0.7470	0.0040	0.0000	--	0.000000	0.0001	0.0000	--	0.00045
7	0.0170	0.0000	--	0.000000	0.0040	0.9150	0.0000	--	0.000000	0.0001	0.0000	--	0.00045
8	0.0200	0.0000	--	0.000000	0.0400	0.3100	0.0000	--	0.000000	0.0001	0.0000	--	0.00045
9	0.0200	0.0000	--	0.000000	0.0400	0.3100	0.0000	--	0.000000	0.0001	0.0000	--	0.00045
10											0.0000	--	0.00045
11											0.0000	--	0.00045
12											0.0000	--	0.00045

See notes at end of table.

(continued)

TABLE D-17 (continued)

	Weighted emissions factors for injection wells (D79) using vapor pressure surrogates				Weighted emission factors for onsite active landfills (D80) using vapor pressure surrogates				Emission factors for onsite closed landfills (D80) using vapor pressure surrogates			
Surrogate	f(air)	f(sp)	f(load)	h(fug)	f(air)	f(sp)	f(load)	h(fug)	f(air)	f(sp)	f(load)	h(fug)
1	--	0.0000	--	0.00000	0.2230	0.0000	--	--	0.0091	0.0000	--	--
2	--	0.0000	--	0.00000	0.2870	0.0000	--	--	0.0027	0.0000	--	--
3	--	0.0000	--	0.00000	0.3110	0.0000	--	--	0.0171	0.0000	--	--
4	--	0.0000	--	0.00000	0.0300	0.0000	--	--	0.0002	0.0000	--	--
5	--	0.0000	--	0.00000	0.0300	0.0000	--	--	0.0001	0.0000	--	--
6	--	0.0000	--	0.00000	0.0410	0.0000	--	--	0.0003	0.0000	--	--
7	--	0.0000	--	0.00000	0.0002	0.0000	--	--	0.0000	0.0000	--	--
8	--	0.0000	--	0.00000	0.0002	0.0000	--	--	0.0000	0.0000	--	--
9	--	0.0000	--	0.00000	0.0002	0.0000	--	--	0.0000	0.0000	--	--
10	--	0.0000	--	0.00000	0.4870	0.0000	--	--	0.0435	0.0000	--	--
11	--	0.0000	--	0.00000	0.7000	0.0000	--	--	0.0051	0.0000	--	--
12	--	0.0000	--	0.00000	0.7000	0.0000	--	--	0.0051	0.0000	--	--

See notes at end of table.

(continued)

TABLE D-17 (continued)

Surrogate	Weighted emission factors for commercial active landfills (D80) using vapor pressure surrogates				Weighted emission factors for closed commercial landfills (D80) using vapor pressure surrogates				Weighted emission factors for land treatment surface application (D81) using vapor pressure surrogates			
	f(air)	f(sp)	f(load)	k(fug)	f(air)	f(sp)	f(load)	k(fug)	f(air)	f(sp)	f(load)	k(fug)
1	0.1110	0.0000	--	--	0.0076	0.0000	--	--	1.0000	0.0000	--	--
2	0.1030	0.0000	--	--	0.0070	0.0000	--	--	1.0000	0.0000	--	--
3	0.1550	0.0000	--	--	0.0146	0.0000	--	--	1.0000	0.0000	--	--
4	0.0160	0.0000	--	--	0.0031	0.0000	--	--	0.2663	0.0000	--	--
5	0.0150	0.0000	--	--	0.0001	0.0000	--	--	0.3943	0.0000	--	--
6	0.0210	0.0000	--	--	0.0002	0.0000	--	--	0.8551	0.0000	--	--
7	0.0001	0.0000	--	--	0.0000	0.0000	--	--	0.0020	0.0000	--	--
8	0.0001	0.0000	--	--	0.0000	0.0000	--	--	0.0020	0.0000	--	--
9	0.0001	0.0000	--	--	0.0000	0.0000	--	--	0.0020	0.0000	--	--
10	0.2420	0.0000	--	--	0.0367	0.0000	--	--	1.0000	0.0000	--	--
11	0.3560	0.0000	--	--	0.0798	0.0000	--	--	1.0000	0.0000	--	--
12	0.3560	0.0000	--	--	0.0798	0.0000	--	--	1.0000	0.0000	--	--

See notes at end of table.

(continued)

TABLE D-17 (continued)

	Weighted emission factors for land treatment subsurface injection (D81) using vapor pressure surrogates				Weighted emission factors for disposal impoundments (D83) using Henry's law surrogates				Weighted emission factors for terminal loading of containers (L01)		
Surrogate	f(air)	f(sp)	f(load)	k(fug)	f(air)	f(sp)	f(load)	k(fug)	f(sp)	f(load)	k(fug)
1	0.8400	0.0000	--	--	1.0000	0.0000	--	0.00011	0.0001	--	0.0000
2	0.9640	0.0000	--	--	1.0000	0.0000	--	0.00011	0.0001	--	0.0000
3	0.9960	0.0000	--	--	1.0000	0.0000	--	0.00011	0.0001	--	0.0000
4	0.1610	0.0000	--	--	1.0000	0.0000	--	0.00011	0.0001	--	0.0000
5	0.3310	0.0000	--	--	1.0000	0.0000	--	0.00011	0.0001	--	0.0000
6	0.8320	0.0000	--	--	1.0000	0.0000	--	0.00011	0.0001	--	0.0000
7	0.0020	0.0000	--	--	0.4700	0.0000	--	0.00011	0.0001	--	0.0000
8	0.0020	0.0000	--	--	0.6300	0.0000	--	0.00011	0.0001	--	0.0000
9	0.0020	0.0000	--	--	0.6300	0.0000	--	0.00011	0.0001	--	0.0000
10	0.9550	0.0000	--	--					0.0001	--	0.0000
11	0.9990	0.0000	--	--					0.0001	--	0.0000
12	0.9990	0.0000	--	--					0.0001	--	0.0000

See notes at end of table.

(continued)

TABLE D-17 (continued)

	Weighted emission factors for terminal loading from impoundments and tanks (L02) using Henry's law surrogates			Weighted emission factors for terminal loading from storage tanks (L03) using vapor pressure surrogates			Weighted emission factors for waste fixation using vapor pressure surrogates[d]			
Surrogate	f(sp)	f(load)	k(fug)	f(sp)	f(load)	k(fug)	f(air)	f(sp)	f(load)	k(fug)
1	0.00001	0.0013	0.00799	0.00001	0.0013	0.00799	0.6000	0.0000	--	--
2	0.00001	0.0011	0.00799	0.00001	0.0013	0.00799	0.6800	0.0000	--	--
3	0.00001	0.0018	0.00799	0.00001	0.0018	0.00799	0.6800	0.0000	--	--
4	0.00001	0.0000	0.00799	0.00001	0.0000	0.00799	0.5300	0.0000	--	--
5	0.00001	0.0000	0.00799	0.00001	0.0000	0.00799	0.5300	0.0000	--	--
6	0.00001	0.0000	0.00799	0.00001	0.0000	0.00799	0.5300	0.0000	--	--
7	0.00001	0.0000	0.00799	0.00001	0.0000	0.00799	0.0500	0.0000	--	--
8	0.00001	0.0000	0.00799	0.00001	0.0000	0.00799	0.0500	0.0000	--	--
9	0.00001	0.0000	0.00799	0.00001	0.0000	0.00799	0.0500	0.0000	--	--
10				0.00001	0.0009	0.00799	0.6800	0.0000	--	--
11				0.00001	0.0140	0.00799	0.6800	0.0000	--	--
12				0.00001	0.0140	0.00799	0.6800	0.0000	--	--

Note: Dash indicates emission factors not applicable.

[a] Some waste management processes, such as S01, S02, and S03, lack a column for biodegradation fraction. They have no biodegradation component, or biodegradation has been considered in the air emission factor determination, and they are read in SAM as zeros.

Values of 0.0000 do not imply that the emission factors equal zero. Rather, 0.000 reflects values less than 0.001 percent.

[b] The f(__) in the column headings represent fractions emitted or degraded. The k(f) in the last column represents fractions emitted from equipment (e.g., pumps, valves, open-end line, etc.).

f(air) = process emissions fraction leaks associated with the waste management process.
f(bio) = biodegradation fraction
f(sp) = spills fraction
k(f) = equipment leak fraction.

[c] Loading emissions included in f(air).

[d] Emission factors for waste fixation are based on the information and data contained in a report prepared by Acurex Corp. for the U.S. EPA titled "Volatile Emissions from Stabilized Waste in Hazardous Waste Landfills," Project 8106, Contract 68-02-3993, January 23, 1987.

D.2.5 Control Technology and Cost File

A file was developed for the SAM that provides control device efficiencies for each emission control alternative (see Chapter 4.0 of Reference 5) that is applicable to each waste management process. Certain control options are specific to waste form. The control technology file provides control efficiencies for land treatment alternatives and add-on control alternatives among others. The control file is a combined file that includes control costs as well as control efficiencies. Model waste compositions (defined in Appendix C, Section C.2.2, of Reference 5), provided the bases for estimating control costs and control efficiencies by waste form.

Tables D-18 and D-19 present the control cost file broken down by emission source and control option. A key is provided at the bottom of the table that explains the columns and how they are used in the SAM.

One important note is that the control cost profile requires that controls and costs be developed for all physical/chemical waste forms even though certain forms and management processes are incompatible or improbable (e.g., storage of a solid hazardous waste in a closed storage tank or storage of an organic liquid waste in an open impoundment). The SAM dilutes incompatible waste forms, when necessary, but cannot redefine the waste form. Therefore, the cost/control file was modified to estimate emission reductions and costs for all waste forms. The SAM will substitute the control costs for a similar waste form if there are no cost factors for a particular (incompatible) form. For example, cost factors for control of dilute aqueous wastes will be used for estimating control costs of a (diluted) aqueous sludge slurry because this waste form did not have control costs developed specifically.

Costs were developed in a way that allows one to estimate capital and annual costs based on total volume waste throughput. Within each management process, total capital investment and annual operating costs were determined for a range of model units and the appropriate add-on control technologies applicable to these processes. The same waste management process weighting factors used to develop emission factors were used to develop weighted cost factors. Estimation of the costs for applying emission controls to TSDF waste management units would ideally be done using specific information about the characteristics of the waste

TABLE D-18. SUPPRESSION AND ADD-ON CONTROL COST FILE USED BY THE SOURCE ASSESSMENT MODEL[a,b]

TSDF process code (1)	TSDF emission source (2)	Waste form (3)	Vola-tility class (4)	Con-trol index (5)	Emission control option (6)	Control efficiency: Suppres-sion (7)	Control efficiency: Emission control (8)	Trans-fer code (9)	Load-ing (10)	Ser-vice life (11)	Cost-function (12)	Total capital investment, $: a (13)	Total capital investment, $: b × Q (14)	Cost func-tion (15)	Annual operating cost, $: a (16)	Annual operating cost, $: b × Q (17)
S01	Drum Storage	VOC-cont Solid	All	1	Vent to Car Ads		95.00	C	A	20	Linear	0.00	49.000	Linear	0.00	15.000
S01	Drum Storage	Aq Sldg/Slurry	All	1	Vent to Car Ads		95.00	C	A	20	Linear	0.00	72.000	Linear	0.00	21.000
S01	Drum Storage	Dilute Aq	All	1	Vent to Car Ads		95.00	C	A	20	Linear	0.00	89.000	Linear	0.00	27.000
S01	Drum Storage	Org Liquid	All	1	Vent to Car Ads		95.00	C	A	20	Linear	0.00	91.000	Linear	0.00	27.000
S01	Drum Storage	Org Sldg/Slurry	All	1	Vent to Car Ads		95.00	C	A	20	Linear	0.00	64.000	Linear	0.00	20.000
S01	Drum Storage	2-Phase Aq/Org	All	1	Vent to Car Ads		95.00	C	A	20	Linear	0.00	91.000	Linear	0.00	27.000
S01	Dumpster	VOC-cont Solid	All	2	Dumpster Cover	99.00				20	Linear	0.00	6.250	Linear	0.00	1.670
S01	Dumpster	Aq Sldg/Slurry	All	2	Dumpster Cover	99.00				20	Linear	0.00	9.375	Linear	0.00	2.500
S01	Dumpster	Dilute Aq	All	2	Dumpster Cover	99.00				20	Linear	0.00	25.030	Linear	0.00	6.670
S01	Dumpster	Org Liquid	All	2	Dumpster Cover	99.00				20	Linear	0.00	25.640	Linear	0.00	6.840
S01	Dumpster	Org Sldg/Slurry	All	2	Dumpster Cover	99.00				20	Linear	0.00	17.860	Linear	0.00	4.980
S01	Dumpster	2-Phase Aq/Org	All	2	Dumpster Cover	99.00				20	Linear	0.00	25.610	Linear	0.00	6.830
S01	Fugitives- Drum Load	Aq Sldg/Slurry	All	3				C								
S01	Fugitives- Drum Load	Dilute Aq	All	3				C								
S01	Fugitives- Drum Load	2-Phase Aq/Org	All	3				C								
S01	Fugitives- Drum Load	Org Liquid	All	3				C								
S01	Fugitives- Drum Load	Org Sldg/Slurry	All	3				C								
S01	Drum Loading	VOC-Cont Solid	All	4				C	A							
S01	Drum Loading	Aq Sldg/Slur	All	4				C	A							
S01	Drum Loading	Dil Aqueous	All	4				C	A							
S01	Drum Loading	Org Liquid	All	4				C	A							
S01	Drum Loading	Org Sldg/Slurry	All	4				C	A							
S01	Drum Loading	2-Phase Aq/Org	All	4				C	A							
S02	Tank Storage	Sub 2xx for 1xx	All	1	IFR, CAds, Vent to CD	84.5		D		10	Linear	0.00	9.740	Linear	0.00	3.290
S02	Tank Storage	Aq Sldg/Slurry	All	1	IFR, CAds, Vent to CD	88.5		D		10	Linear	0.00	9.740	Linear	0.00	3.290
S02	Tank Storage	Dilute Aq	All	1	IFR, CAds, Vent to CD	91.5		D		10	Linear	0.00	13.210	Linear	0.00	9.450
S02	Tank Storage	Org Liquid	All	1	IFR, CAds, Vent to CD	91.75		D		10	Linear	0.00	12.360	Linear	0.00	4.720
S02	Tank Storage	Org Sldg/Slurry	All	1	IFR, CAds, Vent to CD	91.5		D		10	Linear	0.00	11.080	Linear	0.00	5.710
S02	Tank Storage	2-Phase Aq/Org	All	1	IFR, CAds, Vent to CD	86.5		D		10	Linear	0.00	10.740	Linear	0.00	4.870
S02	Tank Storage	Sub 2xx for 1xx	All	2	Fixed Roof	86.4		D		20	Linear	0.00	14.660	Linear	0.00	1.070
S02	Tank Storage	Aq Sldg/Slurry	All	2	Fixed Roof	98.70		D		20	Linear	0.00	14.660	Linear	0.00	1.070
S02	Tank Storage	Dilute Aq	All	2	Fixed Roof	86.40		D		20	Linear	0.00	18.470	Linear	0.00	1.360
S02	Tank Storage	Org Liquid	All	2	Fixed Roof	99.90		D		20	Linear	0.00	18.590	Linear	0.00	1.370
S02	Tank Storage	Org Sldg/Slurry	All	2	Fixed Roof	99.85		D		20	Linear	0.00	15.310	Linear	0.00	1.120

See notes at end of table.

(continued)

TABLE D-10 (continued)

TSDF process code (1)	TSDF emission source (2)	Waste form (3)	Vola-tility class (4)	Con-trol index (5)	Emission control option (6)	Control efficiency		Trans-fer code (9)	Load-ing (10)	Ser-vice life (11)	Cost function (12)	Total capital investment, $		Cost func-tion (15)	Annual operating cost, $	
						Suppres-sion (7)	Emission control (8)					a (13)	b x Q (14)		a (16)	b x Q (17)
S02	Tank Storage	2-Phase Aq/Org	All	2	Fixed Roof	90.00		D		20	Linear	0.00	15.720	Linear	0.00	1.160
S02	Tank Storage	Sub 2xx for 1xx	All	3	Roof, IFR, CAds, Vent	97.9		D		10	Linear	0.00	20.980	Linear	0.00	3.980
S02	Tank Storage	Aq Sldg/Slurry	All	3	Roof, IFR, CAds, Vent	99.85		D		10	Linear	0.00	20.980	Linear	0.00	3.580
S02	Tank Storage	Dilute Aq	All	3	Roof, IFR, CAds, Vent	97.90		D		10	Linear	0.00	27.660	Linear	0.00	10.500
S02	Tank Storage	Org Liquid	All	3	Roof, IFR, CAds, Vent	99.99		D		10	Linear	0.00	26.840	Linear	0.00	6.150
S02	Tank Storage	Org Sldg/Slurry	All	3	Roof, IFR, CAds, Vent	99.99		D		10	Linear	0.00	22.780	Linear	0.00	6.390
S02	Tank Storage	2-Phase Aq/Org	All	3	Roof, IFR, Cads, Vent	98.70		D		10	Linear	0.00	22.550	Linear	0.00	6.690
S02	Fugitives- Tank Load	Aq Sldg/Slurry	All	4				D								
S02	Fugitives- Tank Load	Dilut Aq	All	4				D								
S02	Fugitives- Tank Load	2-Phase Aq/Org	All	4				D								
S02	Fugitives- Tank Load	Org Liquid	All	4				D								
S02	Fugitives- Tank Load	Org Sldg/Slurry	All	4				D								
S03	Waste Pile	Aq Sldg/Slurry	All	1	HD Cover 30 mil	99.70				5	Linear	0.00	0.310	Linear	0.00	0.080
S03	Waste Pile	Sub 2xx for 3xx	All	1	HD Cover 30 mil	99.70				5	Linear	0.00	0.310	Linear	0.00	0.080
S03	Waste Pile	Sub 7xx for 4xx	All	1	HD Cover 30 mil	49.30				5	Linear	0.00	0.310	Linear	0.00	0.080
S03	Waste Pile	Sub 7xx for 5xx	All	1	HD Cover 30 mil	49.30				5	Linear	0.00	0.310	Linear	0.00	0.080
S03	Waste Pile	2-Phase Aq/Org	All	1	HD Cover 30 mil	49.30				5	Linear	0.00	0.310	Linear	0.00	0.080
S03	Waste Pile	VOC-cont Solid	All	1	HD Cover 30 mil	0.00				5	Linear	0.00	0.310	Linear	0.00	0.080
S04	Stor Impd Surface	Sub 2xx for 1xx	All	1	Syn Membrane	85.00		I		10	Linear	0.00	1.850	Linear	0.00	0.240
S04	Stor Impd Surface	Aq Sldg/Slurry	All	1	Syn Membrane	85.00		I		10	Linear	0.00	1.850	Linear	0.00	0.240
S04	Stor Impd Surface	Dilute Aq	All	1	Syn Membrane	85.00		I		10	Linear	0.00	1.850	Linear	0.00	0.240
S04	Stor Impd Surface	Sub 2xx for 4xx	All	1	Syn Membrane	85.00		I		10	Linear	0.00	1.850	Linear	0.00	0.240
S04	Stor Impd Surface	Sub 2xx for 5xx	All	1	Syn Membrane	85.00		I		10	Linear	0.00	1.850	Linear	0.00	0.240
S04	Stor Impd Surface	2-Phase Aq/Org	All	1	Syn Membrane	85.00		I		10	Linear	0.00	1.850	Linear	0.00	0.240
S04	Stor Impd Surface	Sub 2xx for 1xx	All	2	Struct w Car Adsorp	95.00		I		10	Linear	0.00	10.760	Linear	0.00	3.030
S04	Stor Impd Surface	Aq Sldg/Slurry	All	2	Struct w Car Adsorp	95.00		I		10	Linear	0.00	10.760	Linear	0.00	3.030
S04	Stor Impd Surface	Dilute Aq	All	2	Struct w Car Adsorp	95.00		I		10	Linear	0.00	9.430	Linear	0.00	2.270
S04	Stor Impd Surface	Sub 2xx for 4xx	All	2	Struct w Car Adsorp	95.00		I		10	Linear	0.00	10.760	Linear	0.00	3.030
S04	Stor Impd Surface	Sub 2xx for 5xx	All	2	Struct w Car Adsorp	95.00		I		10	Linear	0.00	10.760	Linear	0.00	3.030
S04	Stor Impd Surface	2-Phase Aq/Org	All	2	Struct w Car Adsorp	95.00		I		10	Linear	0.00	9.430	Linear	0.00	2.270
S04	Fugitives- Imp Load	Aq Sldg/Slurry	All	3				I								
S04	Fugitives- Imp Load	Dilut Aq	All	3				I								
S04	Fugitives- Imp Load	2-Phase Aq/Org	All	3				I								

See notes at end of table.

(continued)

TABLE D-10 (continued)

TSDF process code (1)	TSDF emission source (2)	Waste form (3)	Vola-tility class (4)	Con-trol index (5)	Emission control option (6)	Control efficiency		Trans-fer code (9)	Load-ing (10)	Ser-vice life (11)	Cost function (12)	Total capital investment, $		Cost func-tion (15)	Annual operating cost, $	
						Suppres-sion (7)	Emission control (8)					a (13)	b x Q (14)		a (16)	b x Q (17)
504	Fugitives- Imp Load	Org Liquid	All	3				I								
504	Fugitives- Imp Load	Org Sldg/Slurry	All	3				I								
T01	Tank Surface	Sub 2xx for 1xx	All	1	Fixed Roof	87.50		H		20	Linear	0.00	0.380	Linear	0.00	0.030
T01	Tank Surface	Aq Sldg/Slurry	All	1	Fixed Roof	98.20		H		20	Linear	0.00	0.380	Linear	0.00	0.030
T01	Tank Surface	Dilute Aq	All	1	Fixed Roof	87.50		H		20	Linear	0.00	0.380	Linear	0.00	0.030
T01	Tank Surface	Org Liquid	All	1	Fixed Roof	93.22		H		20	Linear	0.00	0.380	Linear	0.00	0.030
T01	Tank Surface	Org Sldg/Slurry	All	1	Fixed Roof	98.93		H		20	Linear	0.00	0.380	Linear	0.00	0.030
T01	Tank Surface	2-Phase Aq/Org	All	1	Fixed Roof	93.50		H		20	Linear	0.00	0.380	Linear	0.00	0.030
T01	Tank Surface	Sub 2xx for 1xx	All	2	Roof,IFR,CAds,Vent	95.40		H		10	Linear	0.00	0.570	Linear	0.00	0.130
T01	Tank Surface	Aq Sldg/Slurry	All	2	Roof,IFR,CAds,Vent	99.70		H		10	Linear	0.00	0.570	Linear	0.00	0.130
T01	Tank Surface	Dilute Aq	All	2	Roof,IFR,CAds,Vent	95.40		H		10	Linear	0.00	1.160	Linear	0.00	0.390
T01	Tank Surface	Org Liquid	All	2	Roof,IFR,CAds,Vent	99.96		H		10	Linear	0.00	0.710	Linear	0.00	0.280
T01	Tank Surface	Org Sldg/Slurry	All	2	Roof,IFR,CAds,Vent	99.95		H		10	Linear	0.00	0.800	Linear	0.00	0.300
T01	Tank Surface	2-Phase Aq/Org	All	2	Roof,IFR,Cads,Vent	97.10		H		10	Linear	0.00	0.800	Linear	0.00	0.360
T01	Tank Surface	Sub 2xx for 1xx	All	3	IFR,CAds,Vent to CD	84.50		H		10	Linear	0.00	0.220	Linear	0.00	0.10
T01	Tank Surface	Aq Sldg/Slurry	All	3	IFR,CAds,Vent to CD	88.50		H		10	Linear	0.00	0.220	Linear	0.00	0.10
T01	Tank Surface	Dilute Aq	All	3	IFR,CAds,Vent to CD	84.50		H		10	Linear	0.00	0.820	Linear	0.00	0.37
T01	Tank Surface	Org Liquid	All	3	IFR,CAds,Vent to CD	91.75		H		10	Linear	0.00	0.360	Linear	0.00	0.25
T01	Tank Surface	Org Sldg/Slurry	All	3	IFR,Cads,Vent to CD	91.50		H		10	Linear	0.00	0.360	Linear	0.00	0.27
T01	Tank Surface	2-Phase Aq/Org	All	3	IFR,Cads,Vent to CD	86.50		H		10	Linear	0.00	0.800	Linear	0.00	0.36
T01	Tank Surface	Sub 2xx for 1xx	All	4	Roof,Vent to CAds	95.00		G		10	Linear	0.00	0.410	Linear	0.00	0.19
T01	Tank Surface	Aq Sldg/Slurry	All	4	Roof,Vent to CAds	95.00		G		10	Linear	0.00	0.410	Linear	0.00	0.19
T01	Tank Surface	Dilute Aq	All	4	Roof,Vent to CAds	95.00		G		10	Linear	0.00	0.420	Linear	0.00	0.30
T01	Tank Surface	Sub 2xx for 4xx	All	4	Roof,Vent to CAds	95.00		G		10	Linear	0.00	0.410	Linear	0.00	0.19
T01	Tank Surface	Sub 2xx for 5xx	All	4	Roof,Vent to CAds	95.00		G		10	Linear	0.00	0.410	Linear	0.00	0.19
T01	Tank Surface	Sub 2xx for 7xx	All	4	Roof,Vent to CAds	95.00		G		10	Linear	0.00	0.410	Linear	0.00	0.19
T01	Fugitives- 0 Tank Ld	Aq Sldg/Slurry	All	5				H								
T01	Fugitives- 0 Tank Ld	Dilut Aq	All	5				H								
T01	Fugitives- 0 Tank Ld	Org Sldg/Slurry	All	5				H								
T01	Fugitives- 0 Tank Ld	Org Liquid	All	5				H								
T01	Fugitives- 0 Tank Ld	Org Sldg/Slurry	All	5				H								
T01	Fugitives- A Tank Ld	Aq Sldg/Slurry	All	6				G								
T01	Fugitives- A Tank Ld	Dilut Aq	All	6				G								
T01	Fugitives- A Tank Ld	2-Phase Aq/Org	All	6				G								

See notes at end of table.

(continued)

TABLE D-18 (continued)

TSDF process code (1)	TSDF emission source (2)	Waste form (3)	Vola-tility class (4)	Con-trol index (5)	Emission control option (6)	Control efficiency Suppres-sion (7)	Control efficiency Emission control (8)	Trans-fer code (9)	Load-ing (10)	Ser-vice life (11)	Cost function (12)	Total capital investment, $ a (13)	Total capital investment, $ b x Q (14)	Cost func-tion (15)	Annual operating cost, $ a (16)	Annual operating cost, $ b x Q (17)
101	Fugitives- A Tank Ld	Org Liquid	All	6				G								
101	Fugitives- A Tank Ld	Org Sldg/Slurry	All	6				G								
102	Treat Impd Surface	Sub 2xx for 1xx	All	1	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.600	Linear	0.00	0.800
102	Treat Impd Surface	Aq Sldg/Slurry	All	1	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.600	Linear	0.00	0.800
102	Treat Impd Surface	Dilute Aq	All	1	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.300	Linear	0.00	0.500
102	Treat Impd Surface	Sub 2xx for 4xx	All	1	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.600	Linear	0.00	0.800
102	Treat Impd Surface	Sub 2xx for 5xx	All	1	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.600	Linear	0.00	0.800
102	Treat Impd Surface	2-Phase Aq/Org	All	1	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.300	Linear	0.00	0.500
102	Treat Impd Surface	Sub 2xx for 1xx	All	2	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.900	Linear	0.00	1.200
102	Treat Impd Surface	Aq Sldg/Slurry	All	2	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.900	Linear	0.00	1.200
102	Treat Impd Surface	Dilute Aq	All	2	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.500	Linear	0.00	0.700
102	Treat Impd Surface	Sub 2xx for 4xx	All	2	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.900	Linear	0.00	1.200
102	Treat Impd Surface	Sub 2xx for 5xx	All	2	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.900	Linear	0.00	1.200
102	Treat Impd Surface	2-Phase Aq/Org	All	2	Stuct & Car Adsorp	95.00		J		10	Linear	0.00	2.500	Linear	0.00	0.700
102	Fugitives- Imp Load	Aq Sldg/Slurry	All	3				J								
102	Fugitives- Imp Load	Dilut Aq	All	3				J								
102	Fugitives- Imp Load	2-Phase Aq/Org	All	3				J								
102	Fugitives- Imp Load	Org Liquid	All	3				J								
102	Fugitives- Imp Load	Org Sldg/Slurry	All	3				J								
102	Trt Impd Surface	Sub 2xx for 1xx	All	5	Syn Membrane	85.00		J		10	Linear	0.00	0.460	Linear	0.00	0.060
102	Trt Impd Surface	Aq Sldg/Slurry	All	5	Syn Membrane	85.00		J		10	Linear	0.00	0.460	Linear	0.00	0.060
102	Trt Impd Surface	Dilute Aq	All	5	Syn Membrane	85.00		J		10	Linear	0.00	0.460	Linear	0.00	0.060
102	Trt Impd Surface	Sub 2xx for 4xx	All	5	Syn Membrane	85.00		J		10	Linear	0.00	0.460	Linear	0.00	0.060
102	Trt Impd Surface	Sub 2xx for 5xx	All	5	Syn Membrane	85.00		J		10	Linear	0.00	0.460	Linear	0.00	0.060
102	Trt Impd Surface	2-Phase Aq/Org	All	5	Syn Membrane	85.00		J		10	Linear	0.00	0.460	Linear	0.00	0.060
103		VOC-cont Solid		1				E								
103		Aq Sldg/Slurry		1				E								
103		Dilute Aq		1				E								
103		Org Liquid		1				E								
103		Org Sldg/Slurry		1				E								
103				1				E								
103		2-Phase Aq/Org		1				E								
104	Tank Surface	Sub 2xx for 1xx	All	3	IFR,CAds,Vent to CD	84.50		H		10	Linear	0.00	0.220	Linear	0.00	0.10
104	Tank Surface	Aq Sldg/Slurry	All	3	IFR,CAds,Vent to CD	88.50		H		10	Linear	0.00	0.220	Linear	0.00	0.10

See notes at end of table.

(continued)

TABLE D-18 (continued)

TSDF process code (1)	TSDF emission source (2)	Waste form (3)	Volatility class (4)	Control index (5)	Emission control option (6)	Control efficiency: Suppression (7)	Control efficiency: Emission control (8)	Transfer code (9)	Loading (10)	Service life (11)	Cost function (12)	Total capital investment, $: a (13)	Total capital investment, $: b x Q (14)	Cost function (15)	Annual operating cost, $: a (16)	Annual operating cost, $: b x Q (17)
T04	Tank Surface	Dilute Aq	All	3	IFR,CAds,Vent to CD	84.50		H		10	Linear	0.00	0.820	Linear	0.00	0.37
T04	Tank Surface	Org Liquid	All	3	IFR,CAds,Vent to CD	91.75		H		10	Linear	0.00	0.360	Linear	0.00	0.25
T04	Tank Surface	Org Sldg/Slurry	All	3	IFR,Cads,Vent to CD	91.50		H		10	Linear	0.00	0.360	Linear	0.00	0.27
T04	Tank Surface	2-Phase Aq/Org	All	3	IFR,Cads,Vent to CD	86.50		H		10	Linear	0.00	0.800	Linear	0.00	0.36
T04	Fugitives- @ Tank Ld	Aq Sldg/Slurry	All	5				H								
T04	Fugitives- @ Tank Ld	Dilute Aq	All	5				H								
T04	Fugitives- @ Tank Ld	Org Sldg/Slurry	All	5				H								
T04	Fugitives- @ Tank Ld	Org Liquid	All	5				H								
T04	Fugitives- @ Tank Ld	Org Sldg/Slurry	All	5				H								
D79		VOC-cont Solid		1				F								
D79		Aq Sldg/Slurry		1				F								
D79		Dilute Aq		1				F								
D79		Org Liquid		1				F								
D79		Org Sldg/Slurry		1				F								
D79				1				F								
D79		2-Phase Aq/Org		1				F								
D80	Landfill (Open)	Aq Sldg/Slurry	All	1	Earth Cover	11.00				20	Linear	0.00	0.000	Linear	0.00	2.690
D80	Landfill (Open)	Sub 7xx for 3xx	All	1	Earth Cover	11.00				20	Linear	0.00	0.000	Linear	0.00	2.690
D80	Landfill (Open)	Sub 7xx for 4xx	All	1	Earth Cover	11.00				20	Linear	0.00	0.000	Linear	0.00	2.690
D80	Landfill (Open)	Sub 7xx for 5xx	All	1	Earth Cover	11.00				20	Linear	0.00	0.000	Linear	0.00	2.690
D80	Landfill (Open)	2-Phase Aq/Org	All	1	Earth Cover	11.00				20	Linear	0.00	0.000	Linear	0.00	2.690
D80	Landfill (Open)	VOC-cont Solid	All	1	Earth Cover	11.00				0	Linear	0.00	0.000	Linear	0.00	2.690
D80	Landfill (Closed)	VOC-cont Solid	All	3	HD Cover 30 mil	0.00				30	Linear	0.00	0.760	Linear	0.00	0.030
D80	Landfill (Closed)	Aq Sldg/Slurry	All	3	HD Cover 30 mil	93.70				30	Linear	0.00	0.760	Linear	0.00	0.030
D80	Landfill (Closed)	Sub 7xx for 3xx	All	3	HD Cover 30 mil	49.30				30	Linear	0.00	0.760	Linear	0.00	0.030
D80	Landfill (Closed)	Sub 7xx for 4xx	All	3	HD Cover 30 mil	49.30				30	Linear	0.00	0.760	Linear	0.00	0.030
D80	Landfill (Closed)	Sub 7xx for 5xx	All	3	HD Cover 30 mil	49.30				30	Linear	0.00	0.760	Linear	0.00	0.030
D80	Landfill (Closed)	2-Phase Aq/Org	All	3	HD Cover 30 mil	49.30				30	Linear	0.00	0.760	Linear	0.00	0.030
D80	Landfill (Closed)	VOC-cont Solid	All	4	HD Cover 100 mil	0.00				30	Linear	0.00	1.960	Linear	0.00	0.080
D80	Landfill (Closed)	Aq Sldg/Slurry	All	4	HD Cover 100 mil	93.90				30	Linear	0.00	1.960	Linear	0.00	0.080
D80	Landfill (Closed)	Sub 7xx for 3xx	All	4	HD Cover 100 mil	84.80				30	Linear	0.00	1.960	Linear	0.00	0.080
D80	Landfill (Closed)	Sub 7xx for 4xx	All	4	HD Cover 100 mil	84.80				30	Linear	0.00	1.960	Linear	0.00	0.080
D80	Landfill (Closed)	Sub 7xx for 5xx	All	4	HD Cover 100 mil	84.80				30	Linear	0.00	1.960	Linear	0.00	0.080
D80	Landfill (Closed)	2-Phase Aq/Org	All	4	HD Cover 100 mil	84.80				30	Linear	0.00	1.960	Linear	0.00	0.080

See notes at end of table.

(continued)

TABLE D-18 (continued)

TSDF process code (1)	TSDF emission source (2)	Waste form (3)	Vola-tility class (4)	Con-trol index (5)	Emission control option (6)	Control efficiency: Suppres-sion (7)	Control efficiency: Emission control (8)	Trans-fer code (9)	Load-ing (10)	Ser-vice life (11)	Cost function (12)	Total capital investment, $: a (13)	Total capital investment, $: b x Q (14)	Cost func-tion (15)	Annual operating cost, $: a (16)	Annual operating cost, $: b x Q (17)
D83	Fugitives- Imp Load	Aq Sldg/Slurry		1				K								
D83	Fugitives- Imp Load	Sub 2xx for 4xx		1				K								
D83	Fugitives- Imp Load	2-Phase Aq/Org		1				K								
D83	Fugitives- Imp Load	Sub 2xx for 4xx		1				K								
D83	Fugitives- Imp Load	Sub 2xx for 5xx		1				K								
FIP	Fixation Pit	Aq Sldg/Slurry	All	3			95.00			20	Linear	0.00	12.030	Linear	0.00	3.720
FIP	Fixation Pit	Sub 7xx for 3xx	All	3			95.00			20	Linear	0.00	12.030	Linear	0.00	3.720
FIP	Fixation Pit	Sub 7xx for 4xx	All	3			95.00			20	Linear	0.00	12.030	Linear	0.00	3.720
FIP	Fixation Pit	Sub 7xx for 5xx	All	3			95.00			20	Linear	0.00	12.030	Linear	0.00	3.720
FIP	Fixation Pit	2-Phase Aq/Org	All	3			95.00			20	Linear	0.00	12.030	Linear	0.00	3.720
FIP	Fixation Pit	VOC-cont Solid	All	3			95.00			20	Linear	0.00	12.030	Linear	0.00	3.720
LDA	Fugitives- LDA Incin	Aq Sldg/Slurry	All	1				E								
LDA	Fugitives- LDA Incin	Dilute Aq	All	1				E								
LDA	Fugitives- LDA Incin	Org Liquid	All	1				E								
LDA	Fugitives- LDA Incin	Org Sldg/Slurry	All	1				E								
LDA	Fugitives- LDA Incin	2-Phase Aq/Org	All	1				E								

[a] This table contains all cost-related data necessary to estimate control cost impacts with the Source Assessment Model.

[b] The definitions of columns for the TSDF Process Control File are:

1 = Management process code.
2 = Management process definition.
3 = Waste form definition.
4 = Volatility definition.
5 = Emission control numeric indicator.
6 = Emission control definition.
7 = Suppression control efficiency.
8 = Control efficiency.
9 = Letter indicator for engaging fugitive controls; refer to Table D-19, column 1, THL process indicator.
10 = Letter indicator for engaging loading controls; refer to Table D-19, column 1, THL process indicator.
11 = Service life of control equipment (yr).
12 = Cost function description, for capital investment.
13 = Fixed control cost for capital investment.
14 = Throughput multiplier for capital investment.
15 = Cost function description for annual operating cost.
16 = Fixed annual operating cost.
17 = Throughput multiplier for annual operating cost.

TABLE D-19. TRANSFER, HANDLING, AND LOAD CONTROL COST FILE USED BY THE SOURCE ASSESSMENT MODEL[a,b]

THL process indicator (1)	Emission source (2)	Waste form (3)	Vola-tility class (4)	Con-trol index (5)	Emission control option (6)	Control efficiency (suppression) (7)	Ser-vice life (8)	Cost function (9)	Total capital investment, $ a (10)	Total capital investment, $ b x Q (11)	Cost function (12)	Annual operating cost a (13)	Annual operating cost b x Q (14)
A	Drum Loading	VOC-Cont Solid	All	1	Submerged Loading	65.00	15	Linear	0.00	0.43000	Linear	0.00	0.03000
A	Drum Loading	Aq Sldg/Slur	All	1	Submerged Loading	65.00	15	Linear	0.00	0.70000	Linear	0.00	0.04000
A	Drum Loading	Oil Aqueous	All	1	Submerged Loading	65.00	15	Linear	0.00	0.87000	Linear	0.00	0.04000
A	Drum Loading	Org Liquid	All	1	Submerged Loading	65.00	15	Linear	0.00	0.89000	Linear	0.00	0.05000
A	Drum Loading	Org Sldg/Slurry	All	1	Submerged Loading	65.00	15	Linear	0.00	0.64000	Linear	0.00	0.03000
A	Drum Loading	2-Phase Aq/Org	All	1	Submerged Loading	65.00	15	Linear	0.00	0.89000	Linear	0.00	0.05000
B	Truck Loading	Aq Sldg/Slur	All	1	Submerged Loading	65.00	15	Linear	0.00	0.75000	Linear	0.00	0.04000
B	Truck Loading	Oil Aqueous	All	1	Submerged Loading	65.00	15	Linear	0.00	0.92000	Linear	0.00	0.05000
B	Truck Loading	Org Liquid	All	1	Submerged Loading	65.00	15	Linear	0.00	0.94000	Linear	0.00	0.05000
B	Truck Loading	Org Sldg/Slurry	All	1	Submerged Loading	65.00	15	Linear	0.00	0.78000	Linear	0.00	0.04000
B	Truck Loading	2-Phase Aq/Org	All	1	Submerged Loading	65.00	15	Linear	0.00	0.79000	Linear	0.00	0.04000
C	Fugitives- Drum Loading	Aq Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	3.57000	Linear	918.00	0.94100
C	Fugitives- Drum Loading	Oil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	3.57000	Linear	918.00	0.94100
C	Fugitives- Drum Loading	Org liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	3.53000	Linear	918.00	0.94100
C	Fugitives- Drum Loading	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	3.57000	Linear	918.00	0.94100
C	Fugitives- Drum Loading	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	3.57000	Linear	918.00	0.94100
D	Fugitives- Sto Tank Loading	Aq Sldg/Slur	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	1.28000	Linear	918.00	0.33700
D	Fugitives- Sto Tank Loading	Oil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	1.28000	Linear	918.00	0.33700
D	Fugitives- Sto Tank Loading	Org Liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	1.28000	Linear	918.00	0.33750
D	Fugitives- Sto Tank Loading	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	1.28000	Linear	918.00	0.23700
D	Fugitives- Sto Tank Loading	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	1.28000	Linear	918.00	0.33700
E	Fugitives- Incin Load(T03)	Aq Sldg/Slur	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	2.14040	Linear	918.00	0.56430
E	Fugitives- Incin Load(T03)	Oil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	2.14040	Linear	918.00	0.56430
E	Fugitives- Incin Load(T03)	Org Liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	2.14040	Linear	918.00	0.56430
E	Fugitives- Incin Load(T03)	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	2.14040	Linear	918.00	0.56430
E	Fugitives- Incin Load(T03)	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	2.14040	Linear	918.00	0.56430
F	Fugitives-Inj Well Load(D79)	Aq Sldg/Slur	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.11300	Linear	918.00	0.07990
F	Fugitives-Inj Well Load(D79)	Oil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.11300	Linear	918.00	0.07990
F	Fugitives-Inj Well Load(D79)	Org Liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.11300	Linear	918.00	0.07990
F	Fugitives-Inj Well Load(D79)	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.11300	Linear	918.00	0.07990
F	Fugitives-Inj Well Load(D79)	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.11300	Linear	918.00	0.07990
G	Fugitives- Aertd Treat Tank Loading	Aq Sldg/Slur	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01630	Linear	918.00	0.00430
G	Fugitives- Aertd Treat Tank Loading	Oil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01630	Linear	918.00	0.00430
G	Fugitives- Aertd Treat Tank Loading	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01630	Linear	918.00	0.00430

See notes at end of table.

(continued)

TABLE D-10 (continued)

TML process indicator (1)	Emission source (2)	Waste form (3)	Volatility class (4)	Control index (5)	Emission control option (6)	Control efficiency (suppression) (7)	Service life (8)	Cost function (9)	Total capital investment, $ a (10)	Total capital investment, $ b x Q (11)	Cost function (12)	Annual operating cost a (13)	Annual operating cost b x Q (14)
G	Fugitives- Aertd Treat Tank Loading	Org Liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01630	Linear	918.00	0.00430
G	Fugitives- Aertd Treat Tank Loading	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01630	Linear	918.00	0.00430
H	Fugitives- Oxct Treat Tank Loading	Aq Sldg/Slur	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.00340	Linear	918.00	0.02300
H	Fugitives- Oxct Treat Tank Loading	Dil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.00340	Linear	918.00	0.02300
H	Fugitives- Oxct Treat Tank Loading	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.00340	Linear	918.00	0.02300
H	Fugitives- Oxct Treat Tank Loading	Org Liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.00340	Linear	918.00	0.02300
H	Fugitives- Oxct Treat Tank Loading	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.00340	Linear	918.00	0.02300
I	Fugitives- Storage Imp Loading	Aq Sldg/Slur	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.73400	Linear	918.00	0.19600
I	Fugitives- Storage Imp Loading	Dil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.73400	Linear	918.00	0.19600
I	Fugitives- Storage Imp Loading	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.73400	Linear	918.00	0.19600
I	Fugitives- Storage Imp Loading	Org Liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.73400	Linear	918.00	0.19600
I	Fugitives- Storage Imp Loading	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.73400	Linear	918.00	0.19600
J	Fugitives- Treat Imp Loading	Aq Sldg/Slur	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01130	Linear	918.00	0.00290
J	Fugitives- Treat Imp Loading	Dil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01130	Linear	918.00	0.00290
J	Fugitives- Treat Imp Loading	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01130	Linear	918.00	0.00290
J	Fugitives- Treat Imp Loading	Org Liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01130	Linear	918.00	0.00290
J	Fugitives- Treat Imp Loading	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.01130	Linear	918.00	0.00290
K	Fugitives- Disp Imp Loading	Aq Sldg/Slur	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.13600	Linear	918.00	0.03500
K	Fugitives- Disp Imp Loading	Dil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.13600	Linear	918.00	0.03500
K	Fugitives- Disp Imp Loading	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.13600	Linear	918.00	0.03500
K	Fugitives- Disp Imp Loading	Org Liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.13600	Linear	918.00	0.03500
K	Fugitives- Disp Imp Loading	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.13600	Linear	918.00	0.03500
M	Fugitives- Terminal Loading	Aq Sldg/Slur	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.89200	Linear	918.00	0.23500
M	Fugitives- Terminal Loading	Dil Aqueous	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.89200	Linear	918.00	0.23500
M	Fugitives- Terminal Loading	Org Liquid	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.89200	Linear	918.00	0.23500
M	Fugitives- Terminal Loading	Org Sldg/Slurry	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.89200	Linear	918.00	0.23500
M	Fugitives- Terminal Loading	2-Phase Aq/Org	All	1	Monthly Inspt/Repair	70.29	10	Linear	6318.00	0.89200	Linear	918.00	0.23500

See notes at end of table.

(continued)

TABLE D-10 (continued)

THL process indicator (1)	Emission source (2)	Waste form (3)	Volatility class (4)	Control index (5)	Emission control option (6)	Control efficiency (suppression) (7)	Service life (8)	Cost function (9)	Total capital investment, $		Cost function (12)	Annual operating cost	
									a (10)	b × Q (11)		a (13)	b × Q (14)

[a]This table contains all cost-related data necessary to estimate control cost impacts with the Source Assessment Model.

[b]The definitions of columns for the TSDF Process Control File are:

1 = Transfer, handling, and loading (THL) process indicator.
2 = Emission source.
3 = Waste form definition.
4 = Volatility definition.
5 = Emission control numeric indicator.
6 = Emission control definition.
7 = Suppression control efficiency.
8 = Service life of control equipment (yr).
9 = Cost function description, for capital investment.
10 = Fixed control cost for capital investment.
11 = Throughput multiplier for capital investment.
12 = Cost function description for annual operating cost.
13 = Fixed annual operating cost.
14 = Throughput multiplier for annual operating cost.

management unit, such as the surface area and waste retention time for surface impoundments. In general, information at that level of detail is not available for all the TSDF. For most TSDF, only the total throughput of the waste management units is known. Therefore, to estimate costs of emission control, it was necessary to derive cost functions that estimate control costs as a function of the waste management unit throughput as was done for the TSDF emission factors. The throughput data available for the TSDF waste management units are total values. For instance, for treatment surface impoundments, a particular facility may have a million gallons per day throughput; however, that could be in one large impoundment or three smaller impoundments. This lack of unit-specific information prevents rigorous determination of facility-specific emission and control cost estimates.

Although the information about the characteristics of specific waste management units is limited, there are statistical data available with which it is possible to describe certain characteristics of the units on a national basis. The Westat Survey conducted in 1981, for instance, provides considerable statistical data useful for determining the national distribution of sizes of storage tanks (storage volume), surface impoundments (surface area), and landfills (surface areas and depth). With these statistical data it is possible to generate cumulative frequency distributions of unit size characteristics. Much of these data, in fact, were the bases for the selection of the model unit sizes. Each model unit has a certain waste throughput and other design and operating characteristics; multiple model units were selected for each waste management process to represent the range of sizes nationally. These model units served as the basis for the development of emission estimates as well as control costs.

The costs for controls applied to the model units were developed and the relationship of control cost to throughput was computed for each of the model units. Because there are no data to determine which of the model unit sizes most closely matches a management process in a particular facility, a method of assigning the model unit costs (and emissions) to each waste management unit in each TSDF, nationally, was needed. To this end, a national average model unit was defined from the statistical information on TSDF management units. Each model unit size was assumed to represent a certain portion of the nationwide cumulative frequency distribution curve for that particular management process. The weighting factor for each management process model unit is the percentage of the cumulative frequency for that model unit. The weighted costs per megagram of waste throughput were then determined by multiplying the weighting factor by the total capital investment and annual operating cost for the corresponding model unit. These weighted costs were compiled for each management process to constitute the control cost file used as input to the SAM. This methodology for developing weighted control cost factors is the same as that used for emission factor determinations and is an approximation of the effects of economy-of-scale on nationwide control cost estimates.

D.2.6 Test Method Conversion Factor File

An important aspect of any pollution control strategy applied to TSDF involves identifying those hazardous waste streams that require control. One means of accomplishing this is to establish control levels based on the emission potential of the waste entering a particular management process. Several test methods have been evaluated to quantify emission potential. The test method selected to measure the waste stream emission potential, which has been defined as the VO content of the waste, is steam distillation with 20 percent (by volume) of the waste distilled for analysis. In general, the VO test method results are a function of the volatility of individual compounds because the amount of a particular waste constituent removed from the waste sample and recovered for analysis depends largely on volatility. The test method results in essentially 100 percent removal and a high distillate recovery for the most volatile compounds in the waste; the removal and recovery of less volatile and more water soluble compounds are less than 100 percent. With a VO test method established, the VO content of a hazardous waste can be measured and then compared to the limits on VO content, established as part of a control strategy, to determine if emission controls are required for the specific waste stream.

Test method conversion factors were developed, based on laboratory test data, to allow the SAM to simulate the VO test method numerically to obtain VO measurements similar to those found in the laboratory. In this way the SAM can determine what waste streams in the data base would be controlled for different VO action levels (waste VO concentration above which controls must be applied to units managing that waste) and, as a result, define the affected population of wastes for a given control strategy. For example, the waste data base used in the SAM contains concentrations of specific compounds in specific waste streams. These compounds are assigned a surrogate designation on the basis of their volatility. The test method conversion factors are applied to each type of surrogate to estimate how much of the surrogate would be removed by the test method and contribute to the total measured VO. The contribution of each surrogate is then summed for the waste to estimate the VO content that the test method would measure. The only use of the test method conversion factors is to estimate (from the data base on waste compositions) what the test method would measure as the VO content of a waste stream. This estimated VO content is compared to the VO concentration limits to determine whether a specific waste stream would be controlled under a given VO action level. The regulated wastes that are identified for control are used in the SAM to determine the nationwide impacts of the given VO action level within a control strategy.

In the development of the conversion factors, several synthetic wastes containing nine select compounds, which represent a wide range of volatilities, were evaluated for percent recovery using the test method. The compounds were present in different types of waste matrices that included aqueous, organic, solids, and combinations of the three. The recovery of these different compounds in different synthetic waste matrices forms the basis for the test method conversion factors.

The approach was to assign each of the nine synthetic waste compounds to its corresponding SAM volatility class based on vapor pressure and Henry's law constant. The normalized percent recovery was used to adjust for recoveries that were either greater than or less than 100 percent. The normalized recovery for each compound in a given volatility class was averaged to provide a single conversion factor for each class. The results are summarized in Table D-20 for each volatility class and type of waste matrix. The results indicate that the method should remove all of the highly volatile compounds from the waste. All of the moderately volatile

TABLE D-20. SUMMARY OF TEST METHOD CONVERSION FACTORS[a]

	Waste matrix		
Volatility class	Aqueous	Organic	Solid
Very high	NA	1.0[b]	1.0[b]
High	1.0	1.0	1.0
Moderate	1.0	0.3	0.5
Low	0.2	0[c]	0[c]

NA = Not applicable.

[a] This table presents factors that, when multiplied by the concentration of a specific volatility class in the waste, provide an estimate of the volatile organic content that the test method would measure for the waste.

[b] Assumes that the test method will remove all of the highly volatile gases from the waste.

[c] Assumes that because of the very low vapor pressure for this category ($<1.33 \times 10^{-4}$ kPa) the test method will remove very little from the waste.

compounds in an aqueous matrix are expected to be removed; however, only 30 to 50 percent of the moderately volatile compounds (conversion factors of 0.3 to 0.5) in an organic or solid matrix are expected to be recovered by the method.

A headspace analysis was also investigated as an alternative procedure for covered tanks because emissions from this source are more directly related to the vapor phase concentration than to the total VO content measured by steam distillation. For the headspace analysis, a conversion factor was also necessary to estimate the vapor phase concentration that the headspace method would measure from a known waste composition. The vapor phase concentration is to be expressed in kilopascals for comparison with existing regulations for storage tanks.

The conversion factors for the headspace method are given in Table D-21. When these factors are multiplied by the concentration in the waste (expressed as weight fraction) for each volatility class, the sum of the results for each class is an estimate of what the headspace methods would measure. These factors were derived from the synthetic waste studies, and each factor is the average from all compounds that are grouped in a given volatility class and waste matrix.

The headspace conversion factors are used with the waste compositions in the SAM's data base to estimate what the headspace method would measure for a given waste stream. The predicted method results are then compared to VO concentration limits for storage tanks to determine whether controls are required. This approach defines the population of controlled wastes, which is used in the SAM to determine the nationwide impacts for controlling covered tanks.

D.2.7 Incidence and Risk File

Health risks posed by exposure to TSDF air emissions typically are presented in two forms: annual cancer incidence (incidents per year nationwide resulting from exposure to TSDF air emissions) and maximum lifetime risk (the highest risk of contracting cancer that any individual could have from exposure to TSDF emissions over a 70-year lifetime). These two health risk forms are used as an index to quantify health impacts related to TSDF emission controls. Detailed discussions on the development of health impacts data are found in Appendixes E and J of Reference 5.

TABLE D-21. SUMMARY OF HEADSPACE CONVERSION FACTORS TO OBTAIN KILOPASCALS (kPa)[a]

	Waste matrix		
Volatility class	Aqueous[b]	Organic	Solid
High	441	24.8	3.93
Medium	26.2	5.10	0.09
Low	3.520	0	0

[a] This table presents conversion factors that are multiplied by the concentration (as weight fraction) of the volatility class in a waste to estimate what the headspace method would measure for that class. For example, with an organic waste containing only medium volatiles at a level of 0.1 weight fraction (10 percent), the headspace method results are estimated as 0.1 x 5.1 = 0.51 kPa.

[b] The results for aqueous wastes are capped by the vapor pressure of the waste constituent surrogate compound (i.e., if the predicted method results exceed the surrogates' vapor pressure, then the vapor pressure should be used as the method measurement).

The Human Exposure Model (HEM) provided the basis in the SAM for estimating annual cancer incidence and risk to the maximum exposed individual due to TSDF-generated airborne hazardous wastes. The HEM is a computer model that calculates exposure levels for a population within 50 km of a facility using 1980 census population distributions and local (site-specific) meteorological data. The HEM was run for each TSDF using a unit risk factor of 1 and a facility emission rate of 10,000 kg/yr. The HEM results were then compiled into risk and incidence files that can be adjusted to reflect the level of actual emissions resulting from implementation of a particular control strategy. The site-specific HEM incidence and risk values are adjusted within the SAM by the ratio of annual facility emissions to 10,000 kg and by the TSDF unit risk factor to give facility-specific estimates for the control strategy under consideration. Individual dual facility incidences are summed to give the nationwide TSDF incidence value.

D.3 OUTPUT FILES

The SAM was developed to generate data necessary for comparison of various TSDF control options in terms of their nationwide environmental, health, economic, and energy impacts. Therefore, emissions (controlled and uncontrolled), costs (capital, annual operating, and annualized), and health impacts (annual cancer incidence and maximum risk) that represent impacts on a national scale are the primary outputs of interest. In addition, the SAM was designed to provide data that could be stored and summarized in a number of ways.

Through manipulation of the SAM post-processor, emissions can be summed and presented by management process (e.g., nationwide emissions for all open storage impoundments), and by source (e.g., nationwide emissions from process losses, spills, or transfer and handling). On a nationwide basis, the emission and cost data are also available for each waste code, for each waste form, and for each constituent within a waste. Emission and cost data are required at this level of detail for comparison and evaluation of the various control strategies being examined. Health impacts, however, are expressed in terms of overall nationwide risk or cancer incidences.

D.4 REFERENCES

1. Memorandum from MacIntyre, Lisa, RTI, to Docket. November 4, 1987. Data from the 1986 National Screening Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities used to develop the Industry Profile.

2. Office of Solid Waste. National Screening Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities. U.S. Environmental Protection Agency. Washington, DC. June 1987.

3. Memorandum from MacIntyre, Lisa, RTI, to Docket. November 4, 1987. Data from the National Hazardous Waste Data Management System used to develop the Industry Profile.

4. Westat, Incorporated. National Survey of Hazardous Waste Generators and Treatment, Storage and Disposal Facilities Regulated Under RCRA in 1981. Prepared for U.S. Environmental Protection Agency. Office of Solid Waste. September 25, 1985.

5. Office of Air Quality Planning and Standards. Hazardous Waste TSDF--Background Information for Proposed RCRA Air Emission Standards, Draft EIS. U.S. Environmental Protection Agency. Research Triangle Park, NC. EPA Publication No. EPA-450/3-89-23. March 1988.

6. Office of Water and Hazardous Waste. Application for Hazardous Waste Permit-Consolidated Permits Program. EPA Forms 3510-1 and 3510-3.7. U.S. Environmental Protection Agency. Washington, DC. June 1980.

7. Code of Federal Regulations. Title 40, Part 261. Identification and Listing of Hazardous Waste. U.S. Government Printing Office. Washington, DC. July 1, 1986. p. 359-408.

8. Code of Federal Regulations. Title 40, Part 262.34(a). Accumulation Time. U.S. Government Printing Office. Washington, DC. July 1, 1986. p. 411.

9. Reference 4, p. 17.

10. U.S. Office of Management and Budget. Standard Industrial Classification Manual. Executive Office of the President. Washington, DC. 1987.

11. Moody's Investors Service, Inc. Moody's Industrial Manual. New York. 1982.

12. North Carolina Department of Commerce. Directory of North Carolina Manufacturing Firms. Industrial Development Division. Raleigh, NC. 1984. 1985-1986.

13. Environmental Information Ltd. Industrial and Hazardous Waste Management Firms. Minneapolis, MN. 1986.

14. U.S. Department of Commerce. Census of Manufactures. Bureau of the Census. Washington, DC. 1982.

15. U.S. Department of Commerce. Census of Mineral Industries. Bureau of the Census. Washington, DC. 1982.

16. U.S. Department of Commerce. Census of Retail Trade. Bureau of the Census. Washington, DC. 1982.

17. U.S. Department of Commerce. Census of Service Industries. Bureau of the Census. Washington, DC. 1982.

18. U.S. Department of Commerce. Census of Wholesale Trade. Bureau of the Census. Washington, DC. 1982.

19. Reference 14.

20. Memorandum from Deerhake, M.E., RTI, to Docket. November 20, 1987. RTI use of the 1981 National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities Data Base (Westat Survey).

21. Memorandum from Deerhake, M.E., RTI, to Docket. November 20, 1987. SAIC nonconfidential printouts of the Industry Studies Data Base.

22. Memorandum from Deerhake, M.E., RTI to Docket. November 20, 1987. Printout of RCRA K waste code data base.

23. ICF, Incorporated. The RCRA Risk-Cost Analysis Model. Phase III Report and Appendices. Prepared for the U.S. Environmental Protection Agency. Office of Solid Waste. Washington, DC. March 1, 1984.

24. Memorandum from Deerhake, M.E., RTI, to Docket. November 20, 1987. RTI use of the WET Model Hazardous Waste data base.

25. Computer printout from the Illinois Environmental Protection Agency. Data Base of Special Waste Streams. Division of Land Pollution Control. August 1986.

26. Code of Federal Regulations. Title 40, Part 261.33(f). Discarded Commercial Chemical Products, Off-Specification Species, Container Residues, and Spill Residues Thereof. U.S. Government Printing Office. Washington, DC. July 1, 1986. p. 382-386.

27. Reference 7.

28. Hazardous Waste TSDF Waste Process Sampling. Volumes I-IV. Prepared by GCA Corporation for U.S. Environmental Protection Agency/Office of Air Quality Planning and Standards, RTP, NC. October 1985.

29. Memorandum from Deerhake, M. E., RTI, to Docket. December 30, 1987. U.S. Environmental Protection Agency. Petroleum Refining Test Data from the OSW Listing Program.

30. Reference 27, Volume I, p. 4-1 through 4-22.

31. Reference 27, Volume III, p.7-1 through 7-12.

32. Letter from Deerhake, M.E., RTI, to McDonald, R., EPA/OAQPS. August 15, 1986. Review of Volumes I-IV of "Hazardous Waste Process Sampling" for test data and OSW data on the petroleum refining industry.

33. Letter from Deerhake, M.E., RTI, to McDonald, R., EPA/OAQPS. September 19, 1986. Waste compositions found in review of field test results.

34. Code of Federal Regulations. Title 40, Part 261, Subpart C - Characteristics of Hazardous Waste and Subpart D - Lists of Hazardous Wastes. U.S. Government Printing Office. Washington, DC. July 1, 1986. p. 373-386.

35. Letter from Deerhake, M.E., RTI, to McDonald, R., EPA/OAQPS. October 1, 1986. Approach for incorporating field test data into the Waste Characterization Data Base.

36. Dun and Bradstreet. Million Dollar Directory. Parsippany, NJ. 1986.

37. Environ Corporation. Characterization of Waste Streams Listed in 40 CFR 261 Waste Profiles, Volumes 1 and 2. Prepared for U.S. Environmental Protection Agency, Office of Solid Waste Characterization and Assessment Division. Washington, DC. August 1985.

38. Radian Corporation. Characterization of Transfer, Storage, and Handling of Waste with High Emissions Potential, Phase 1. Final Report. Prepared for U.S. Environmental Protection Agency. Thermal Destruction Branch. Cincinnati, OH. July 1985.

39. U.S. Environmental Protection Agency. Supporting Documents for the Regulatory Analysis of the Part 264 Land Disposal Regulations. Volumes I-III. Docket Report. Washington, DC. August 24, 1982. Volume I, p. VIII-3.

40. Reference 22, p. 2-17.

41. Code of Federal Regulations. Title 40, Parts 261.31 and 32. Hazardous Wastes from Non-Specific Sources and Hazardous Waste from Specific Sources. U.S. Government Printing Office. Washington, DC. July 1, 1986. p. 377-379.

42. Reference 34, p. 7.

43. Reference 34, p. 35.

44. Code of Federal Regulations. Title 40, Part 261.31. Office of the Federal Register. Washington, DC. July 1, 1986.

45. Metcalf and Eddy, Inc. Wastewater Engineering. New York, McGraw-Hill Book Company. 1972. pp. 231 and 304.

46. Office of Solid Waste. RCRA Land Disposal Restrictions Background Document on the Comparative Risk Assessment. U.S. Environmental Protection Agency. Washington, DC. December 27, 1985. 170 pp.

47. Reference 46.

48. Reference 44.

49. Code of Federal Regulations. Title 40, Part 261.33. Office of the Federal Register. Washington, DC. July 1, 1986.

50. U.S. Environmental Protection Agency. Hazardous Waste Management System: General. 45 FR 33115. May 19, 1980.

51. Reference 34.

52. Industrial Economics, Inc. Regulatory Analysis of Proposed Restrictions on Land Disposal of Certain Solvent Wastes. Draft. Prepared for U.S. Environmental Protection Agency, Office of Solid Waste. Washington, DC. September 30, 1985. p. 3-15.

53. Code of Federal Regulations. Title 40, Part 261.32. Office of the Federal Register. Washington, DC. July 1, 1986.

54. U.S. Environmental Protection Agency. Hazardous Waste Management System; Land Disposal Restrictions: Final Rule. 51 FR 40572. November 7, 1987.

55. Reference 2, Exhibit A-9.

56. Reference 52, p. 3-15.

57. Research Triangle Institute. Hazardous Waste Treatment, Storage, and Disposal Facilities: Air Emission Models, Draft Report. Prepared for U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards. Research Triangle Park, NC. March 1987.

58. Reference 57.

59. U.S. Environmental Protection Agency, OAQPS. Physical-Chemical Properties and Categorization of RCRA Wastes According to Volatility. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA-450/3-85-007. February 1985. p. 15.

60. Reference 59.

61. Merck Index. Ninth Edition. Merck and Co., Inc. Rahway, NJ. 1976.

62. Verschueren, K. Handbook on Environmental Data and Organic Chemicals. New York, Van Nostrand Reinhold Company. 1983.

63. Environ Corp. Characterization of Waste Streams Listed in 40 CFR Section 261: Waste Profiles. Volumes I and II. Prepared for U.S. Environmental Protection Agency. Washington, DC. August 1985.

64. University of Arkansas. Emission of Hazardous Chemicals from Surface and Near-Surface Impoundments to Air. Draft Final Report. EPA Project No. 808161-02. December 1984.

65. Reference 59.

66. Memorandum from Zerbonia, R., RTI, to Hustvedt, K. C., EPA/OAQPS. Development of waste constituent categories' (surrogates) properties for the Source Assessment Model. December 30, 1987.

67. Reference 66.

68. Reference 66.

69. Reference 61.

70. Reference 62.

71. Reference 62.

72. Reference 56.

73. Chemical Manufacturers Association. Comments of the Chemical Manufacturers Association on the Environmental Protection Agency Document "Hazardous Waste TSDF-Background Information for Proposed RCRA Air Emission Standards - Volumes I and II." Washington, DC. July 11, 1988. 105 p.

74. Memorandum from Coy, D., RTI, to Docket. January 1989. Investigation of and Recommendation for Revisions to Aerated Model Unit Parameters Used in the Source Assessment Model.

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-450/3-89-009	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Hazardous Waste Treatment, Storage, and Disposal Facilities--Background Information for Promulgated Organic Emission Standards for Process Vents and Equipment Leaks		5. REPORT DATE June 1990 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Office of Air Quality Planning and Standards Environmental Protection Agency Research Triangle Park, North Carolina 27711		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. 68-02-4326
12. SPONSORING AGENCY NAME AND ADDRESS DAA for Air Quality Planning and Standards Office of Air, Noise, and Radiation U.S. Environmental Protection Agency Research Triangle Park, North Carolina 27711		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE EPA/200/04
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

Standards for the control of organic air emissions from hazardous waste treatment, storage, and disposal facilities (TSDF) and waste solvent treatment facilities (WSTF) are promulgated under the authority of Section 3004(n) of the 1976 Resource Conservation and Recovery Act (RCRA). These standards would apply to certain process vents associated with distillation and stripping equipment at WSTF (and at TSDF, if applicable) and to fugitive emissions from equipment leaks at TSDF where the waste stream (or its derivatives) contain 10 percent or more total organics. This document contains summaries of public comments received on the proposed rule (February 5, 1987), EPA responses, and a discussion of differences between the proposed and final standards.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air pollution Benzene Carcinogenic Equipment leaks Hazardous waste National emission standards for hazardous air pollutants Process vents Recycling Treatment, storage, and disposal facilities Volatile organics Waste solvent treatment facilities	Air pollution control	13 B

18. DISTRIBUTION STATEMENT Unlimited	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE